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BULLETIN

OF THE

NEW YORK STATE MUSEUM

OF

NATURAL HISTORY.

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No. 3.

MARCH, 1888.

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BUILDING STONE IN THE STATE OF NEW YORK,

BY JOHN C. SMOCK.

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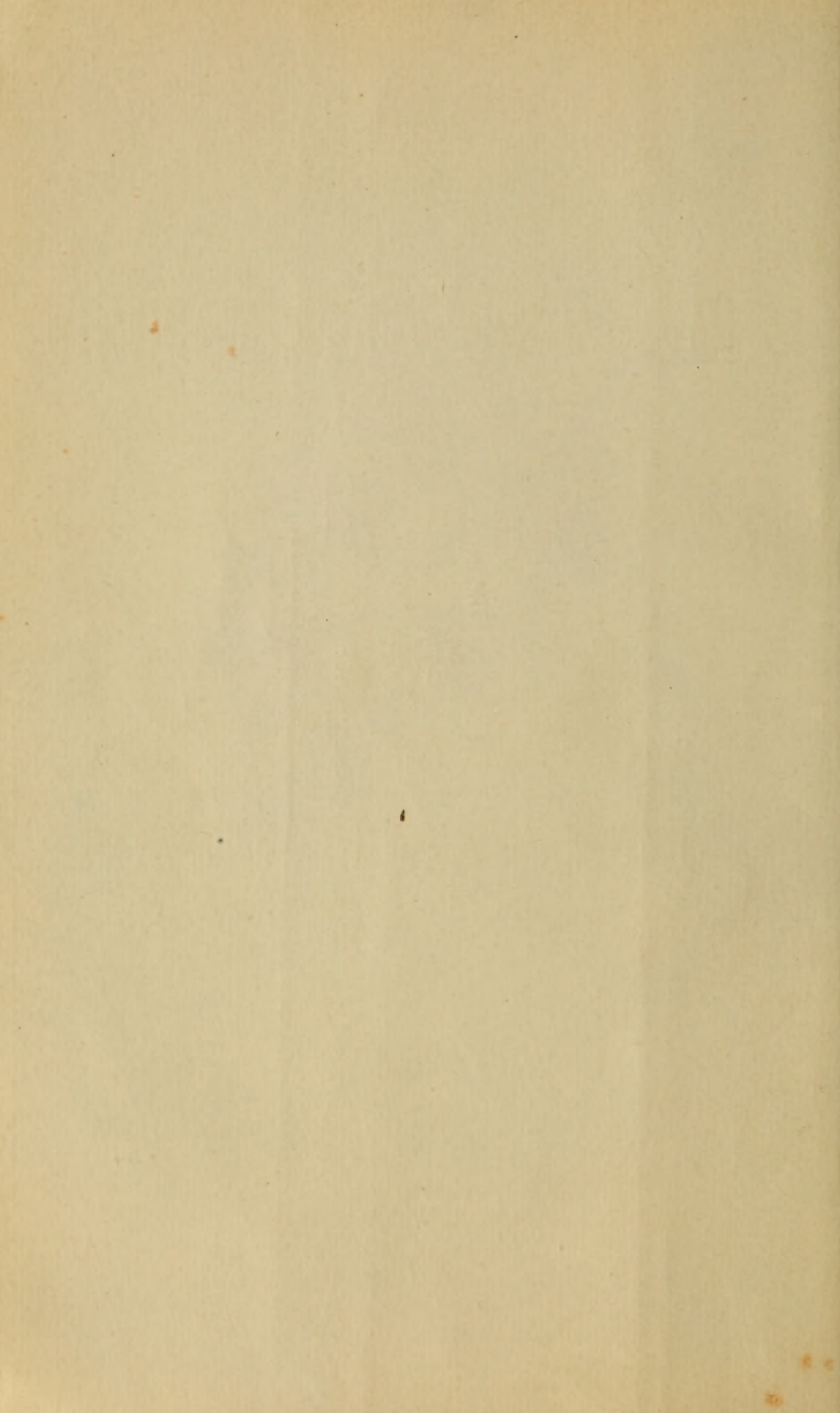
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ALBANY:

CHARLES VAN BENTHUYSEN & SONS.

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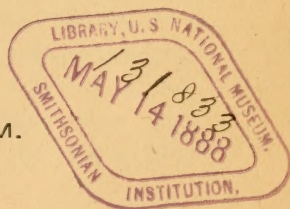
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## PREFACE.

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Economic geology, as a division of the New York State Museum, has for its work the examination and description of the mineral staples which occur in the State. An account of the building stones, and a notice of them, in the form of a bulletin, was proposed in the autumn of 1886. The work of visiting the quarry districts and collecting the necessary data was begun in October of that year, and occupied parts of two field seasons. All of the large quarries were visited, and notes of their location, extent and business were gathered. Many rock specimens, representative of the varieties of stone quarried, were obtained. It was impossible to go to all the localities; and circular letters, asking for information, were sent to them, so far as they were known. The many answers which have come from quarry owners and managers, have filled, in part, the gaps in the field notes, and furnished the material for the descriptions of these localities.

The scope of the work, as planned, included the location, extent, geological relations and ownership of the quarries, and their statistics of capital, plant, labor, product, markets and prices. It was soon found that full and accurate data from each individual owner, in answer to all of the inquiries, were not to be had. The statistics, relating more particularly to the business, were then sought from the large property owners and managers, who could give close estimates for their own districts. Their answers came promptly; and the information from them is more nearly accurate than any census made up of the individual statements of quarrymen.

Another aim in the work was to make collections of specimens, and to have the microscopic examinations, chemical analyses and physical tests made of them, which would show their composition, structure, hardness, strength, durability, and comparative value as constructive material. The field collections are yet too incomplete; and the examination and study of specimens is reserved, necessarily, for a subsequent bulletin.

In the preparation of this bulletin the aim has been to make the descriptive notes plain and serviceable to all interested in the subject, and to exclude the purely scientific observations of the field, leaving them to be incorporated with the discussion of the occurrence, properties and general, economic relations of the building stone, which is used in our State.

In conclusion, I must acknowledge my indebtedness to the many quarry owners, managers and superintendents, who have kindly given their time and attention, in contributing valuable notes and statistics. Special acknowledgments for data of quarry districts are due to Messrs. Samuel Coykendall and Samuel Coles, of the Union Blue Stone Company, of New York; Gilbert Brady, Rochester; L. D. Leonard, Albion; C. A. Gorman, Medina; Edward Merritt and Thomas S. Clarkson, Potsdam; D. A. Parmeter, Hammond; Thomas J. Whitney, Gouverneur; David Black, of the Thousand Island Granite Company, Thurso; Jas. Hughes and Wm. Crabtree, Syracuse; N. Hewitt, Amsterdam; W. A. Nixon, and Edward Willis of the Penryhn Slate Company, Middle Granville; Wm. B. Fitch, Kingston; and F. G. Clarke, Oxford.

To Prof. James Hall, State Geologist, I am indebted for many facts bearing on the geological horizon of our quarries.

JOHN C. SMOCK.

NEW YORK STATE MUSEUM,  
ALBANY, N. Y., *March 5, 1888.*



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## GENERAL

# Classification and Arrangement.

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Any division of the building stones (or stone used in construction), which occur naturally, is to some extent arbitrary. The basis for it may be in the nature of the rock as to its constituent minerals, their arrangement and their relative proportion in the mass, or it may be in the formation, or geological horizon whence it comes. The latter has regard to the source rather than the nature or kind of rock. Thus granites and gneisses differ in the arrangement of the minerals which make up the rock or stone and not, necessarily, in the minerals or even in their chemical composition. Again, for example, limestones and marbles differ in the degree of crystallization and not in chemical composition. Then, again there are sandstones, slates, serpentines and trap-rocks, classes which differ mineralogically and chemically. From the stand point of geology the natural building stones may belong to widely different geological formations or ages and yet in their composition be almost identical. Sandstones and limestones especially are widely represented in the various formations. Marble may come from the oldest or Archæan or from the Silurian or from the later geological rock outcrops. In our own State the Tuckahoe and Sing Sing marbles, the coral-shell marble of Hudson, the Glens Falls black marble and the Lockport marble are representatives of different geological epochs. And the so-called *granites* comprehend rocks, which differ in their mineralogical constitution and in the formation to which they belong. The division or arrangement, which is indicated by the geological age is, therefore, not so natural or definite as the former. But it is serviceable in a secondary division or subdivision of the classes, which rest upon mineral differences.

The best classification is, primarily into the *kinds* of rock or stone, and, secondarily, into groups corresponding to the several geological formations. The first are fully recognized in the practical and business circles; the geological grouping also is known, but is not so generally appreciated and understood. In New York the characters of some of the geological subdivisions have been so carefully studied as to become well known, and they are so persistent that they are types. The Black River limestone, the Trenton limestone, the Onon-



daga gray limestone, the Potsdam sandstone, the Oneida conglomerate and the Medina sandstone are nearly as well known and as readily recognized by the practical quarrymen as by geological experts. And in the State the outcrops of these formations are to some extent natural divisions, whose topography and general surface characters are due to these rocks. Hence in the geographical distribution of the several kinds of rock or stone, the limits are determined by the extent of the geological formations. And a geological map of the State shows where they may be found.

The arrangement, as indicated above, is into the following kinds of rock and the geological groups to which they belong :

### KINDS OF ROCK.

#### I. CRYSTALLINE ROCKS.

1. Granites, syenites, gneisses, mica schists.
2. Trap-rocks.
3. Marbles, serpentines.

#### II. SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.\*

1. Quartzytes and sandstones.
2. Limestones.
3. Slates.

The rocks of the sub-crystalline and fragmental division are subdivided and arranged in the following geological groups :

#### SANDSTONE.

|                     |                    |
|---------------------|--------------------|
| Potsdam.            | Portage.           |
| Hudson River group. | Chemung.           |
| Medina.             | Catskill.          |
| Clinton group.      | New Red Sandstone. |
| Hamilton.           |                    |

#### LIMESTONES.

|              |                   |
|--------------|-------------------|
| Calciferous. | Lower Helderberg. |
| Chazy.       | Upper Helderberg. |
| Trenton.     | Tully Limestone.  |
| Niagara.     |                   |

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\* Many of the rocks in this second general head are crystalline or sub-crystalline; but as the structure in nearly all cases is not recognizable by the unaided eye, the division is consistent with practice and is retained. The strictly fragmental rocks are slates, sandstones and conglomerates. Building stones are sometimes classified as crystalline, sedimentary and calcareous rocks.

## GEOLOGICAL POSITION

— AND —

# Geographical Distribution of Building Stone

## IN NEW YORK.

The crystalline rocks are limited in the outcrops to the Adirondaek region, the Highlands of the Hudson,\* Westchester and New York counties, the Rockland county trap range, Staten Island and a very small area on Long Island. The Hudson-Champlain valley, a part of the St. Lawrence valley and the central, southern-central and western parts of the State have sandstones and limestones as *native* building stone.

The geological horizon, the occurrence, the localities and general notes on the building stone of the several subdivisions or groups are given here under their respective heads.

### I.—CRYSTALLINE ROCKS.

#### 1. GRANITES, SYENITES, GNEISSES, MICA SCHIST.

Granite, in its proper signification, is a crystalline rock, consisting of feldspar, quartz and mica. These constituents are aggregated together in an intimate mixture and in varying proportions. The minerals may be of larger or smaller size, from the scarcely discernible grains or crystals to masses an inch or more in length; and hence the stone is said to be coarse-grained or fine-grained, or coarse crystalline and fine-crystalline. But the typical granite is not the more common form or variety. Besides the essential, constituent minerals, there are hornblende, pyroxene, epidote, garnet, tourmaline, magnetite, pyrite, chlorite, graphite, any of which may come in as accessory minerals. Generally some one of these minerals is present

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\*The crystalline rocks of eastern Dutchess county and a part of Columbia are included in the Highlands.

and gives character to the mass. Often it happens that the mica is almost entirely wanting, and is replaced by one of these accessory constituents. Thus there may be a hornblendic granite or a graphitic or epidotic variety, etc., according to the nature of the mineral.

Syenite differs from granite in having little quartz, no mica and hornblende.

Parallel in composition with granites, but differing in texture, are the gneisses or gneissic rocks. They are stratified or lie in strata or beds. In them the minerals are in thin, lenticular layers and laminae which are parallel to the bedding-planes of the rock. The mass is said to be laminated, or schistose in structure. Sometimes the component minerals are so large that in hand specimens it is not possible to decide if they be gneiss or granite. And they may be fine-granular and coarse-granular in texture. Graphitic, epidotic, hornblendic, garnetiferous and other varieties occur, determined by the accessory constituents.

Mica schist is an aggregate of quartz and mica mainly and having a more marked schistose structure than the gneisses. The lenticular form of the quartz is especially noticeable. And on account of its structure it is more readily split in the plane of its bedding than the granites or the gneisses. Generally the plates or scales of mica lie rudely parallel to one another and they help in giving the mass a more laminated appearance and cause it to have a more fissile character.

It must be understood that there is a wide range in the relative proportions in which these essential, rock-forming minerals occur in these several kinds of crystalline rocks. One or another may predominate and give character to the mass. As in the deposits which are to-day in process of formation, these old rock masses differ within narrow limits. And not only do we find variation from one locality to another, but also in the same ledge and quarry, and in some places in the same bed. These mineralogical differences generally indicate a different chemical composition also, although not in all cases. But to the quarryman and builder the former are of much more importance, since they give strength and make it durable, or determine its clearance and the style of working. The texture is wholly controlled by the mode of aggregation and the nature of the minerals. Where uniformly distributed and not in lines or layers the mass is split with equal ease in any direction, and it is capable of being dressed with like degree of fineness on any side. But such crystalline aggregates



are rare and nearly all of the granite and syenite can be cleft in one way more readily than in another, that is, the stone is said to have a *grain* to it. The durability also is affected by the nature of the minerals. Thus, pyrite may occur, and by its decomposition cause decay. Or there may be a more easily decomposing feldspar which by its decay will make the mass to crumble. Or by an excess of mica the stone may be particularly liable to split or scale off, when exposed to the action of freezing weather. Owing to these almost infinite variations in composition and, consequently, in structure and texture no general description will cover all the forms and varieties. But it may be said here that there is comparatively little of the massive and unstratified (granites and syenites) varieties. The greater part of the crystalline rocks, particularly in the south-eastern part of the State, occurs in beds as schistose gneisses and granitoid and syenite gneisses. The stratified condition is predominant in all the border of the Adirondack region also.

The term granite is applied to rocks found in great masses and outcrops over large areas in the central and eastern portions of the Adirondack region, which are not strictly such. Instead of potash feldspar they have a lime feldspar (labradorite) and with it quartz and hornblende.

Granites, syenites, gneisses and mica schist occur in the counties of Rockland, Orange, Westchester, Putnam and Dutchess and on New York island. For constructive material quarries have been opened at many points, generally near railway lines or on the Hudson river. The Breakneck and Storm King mountain granite quarries were opened many years ago, and described in Mather's report on the First District of the State. Gneiss has been quarried at Spuyten Duyvill ; near Hastings ; at Valentine's, east of Yonkers ; at Fordham ; near Hartsdale ; at Kensico ; at Tarrytown, in Westchester county ; at Ganung's quarry, west of Croton Falls ; at Cold Spring and near Anthony's Nose, north-west of Peekskill in Putnam county ; at Ramapo, in Rockland county ; and in Orange county, at West Point, Cozzens and Fort Montgomery. There are many other localities where stone has been quarried for local use, which are not worked for export, or steadily as quarries. The outcrops of gneissic rocks are so numerous and so extensive that the supply is inexhaustible, and the number of quarries which can be opened is equalled only by the area of territory covered by these outcrops. Particularly advantageous locations are to be seen along the Hudson river from

Peekskill to Fishkill, in the Highlands. The Ramapo river valley, which is traversed by the New York, Lake Erie and Western railroad, the Harlem, the New Haven, and the New York City and Northern railroad lines, cross the territory of these crystalline rocks. Mica schist and micaceous gneisses occur on New York island, in Westchester county, and in the eastern parts of Putnam and Dutchess counties. They are quarried wherever they are conveniently had, for home use and generally for common wall work and foundations. A great amount has been used in New York city in foundations and in backs of walls with other stone as face material. In the great Adirondack region and its bordering zone of crystalline rocks, occupying Essex and Hamilton, and large parts of Clinton, Franklin, St. Lawrence, Jefferson, Lewis, Herkimer, Fulton, Saratoga, Warren and Washington counties, there is a great variety in the outcrops, but comparatively little work has been done, excepting at a few places on the outskirts of the region, to develop quarries of granite or gneiss. In Saratoga county a quarry in Wilton is worked for paving-blocks. In Essex county quarries have been opened in recent years in Willsborough and near Keeseville. On the north-west there is a quarry near Canton in St. Lawrence county, and the quarries on Grindstone island in the St. Lawrence. At the extreme southern end of the region where it reaches the Mohawk gneiss is quarried to a considerable extent at Little Falls. Other localities are in Greenfield and Hadley, in Saratoga, and at Whitehall in Washington counties.

The want of transportation facilities in all the great interior, the distance from the great city markets, which call for granites particularly, and the more accessible outcrops of limestone and sandstone, which border it, and are nearer the towns and lesser markets, are against the opening of granite quarries in the Adirondack region. Future exploration will no doubt lead to the discovery of beautiful and valuable stone, and the building of railroads will bring them to notice and to market. On the line of the Adirondack railroad and the lines of the Delaware and Hudson Canal Company, and on the shore of Lake Champlain, the work of opening new quarries is in progress and is promising of profitable results. On Grindstone island, near Clayton, Jefferson county, a very large quantity of granite has been quarried for western markets.

## 2. TRAP-ROCK.

Trap-rock is the common name given to a certain class of eruptive or igneous rocks, which are unstratified. They are made up of a feldspar (usually labradorite) and augite, with some magnetite and titanite iron. The mass is generally of a dark color and finer-grained than the granites. The rock of the Palisades opposite New York city is an example. In New York these trap-rocks make up the Palisade mountain range and the Torne mountain, on the west side of the Hudson river from the New Jersey line to Haverstraw. There is an outcrop on Staten Island also, where the rock was quarried under the name of *granite*. The only place where the stone is steadily worked is on the river bluff at Rockland Lake.

The existence of unstratified rocks of this group in the Adirondack region is known, but of their extent and localities there is much uncertainty. Their importance as a source of material for constructive uses is inconsiderable where there is so much granite, gneiss and other stone which are worked more economically and dressed more readily.

## 3. MARBLES.

*Marble* has been defined to be "limestone which has a granular texture." But as already noted, the term is used in New York State to apply to any calcareous rock which takes a fine polish and may be used as an ornamental or decorative material. In this report the term is restricted to the crystalline limestones, whether massive or unstratified, or metamorphosed or altered sediments. The texture and not the use is the basis of the distinction between ordinary limestones, which are not crystalline, and the marbles. Crystalline limestone is a common rock in Westchester, Putnam and in the eastern part of Dutchess counties. There are small outcrops in Orange county also. The Adirondack region has its belts of the same rock. And, in general the territory of the granites, gneisses and syenites contains here and there patches of crystalline limestone, and also possible sources of marble. Marble has been quarried at King's Bridge and Tremont in New York city; at Tuckahoe, Scarsdale and Pleasantville near the Harlem railroad line; at Hastings, Sparta and Sing Sing on the Hudson river; and at South Dover and Dover Plains in the eastern part of Dutchess county. In the Champlain valley there is a quarry at Port Henry. On the north-west side of the Adirondacks there are large quarries at Gouverneur.



As a supplement to this list the "*coral shell marble*" near Hudson and the "*Lepanto*" marble near Plattsburgh are here added.

When the calcareous rock contains some serpentine the term verd-antique marble is given to it. And such a marble has been quarried in the town of Thurman, Warren county.

The geological age of the crystalline limestones, which occur in the State, and which are known by quarrymen as marbles, is, in some cases, doubtful. The outcrops in the Highlands of the Hudson and in the Adirondack region are probably all Laurentian. The belt in the eastern parts of Dutchess and Putnam counties, which in its northern extension is one with the Vermont marble region, is metamorphosed or altered Trenton limestone. The Westchester marbles may belong in the same horizon.

## II.—SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.

### 1. SANDSTONES AND QUARTZITES.

Sandstones are rocks made up of grains of quartzose sand, which are cemented together by siliceous, ferruginous, calcareous or argillaceous material. In some cases mica, feldspar or other minerals, are mixed with the quartz sand, and then they are termed micaceous, feldspathic, etc. From the nature of the cement holding the grains together the rocks are variously designated as ferruginous, or iron sandstone, or sometimes brownstone, as calcareous sandrock, etc. The component parts may be coarse-grained or fine-grained. There is an almost infinite variety in respect to shades of color, degree of texture and nature of cement. And the hardness, strength, density and durability are determined by these elements. Their value as building material depends upon the physical constitution quite as much as upon the chemical composition. Without a good bond the grains fall apart and the stone is friable or crumbling. If the cementing material be one which decomposes readily, as in the case of some of the more argillaceous or shaly varieties, or in the calcareous sandrocks, the whole mass is soon reduced to sand. Examples of sandstones, weak through such causes, are common. When the quartz grains are, as it were, run together and form a kind of vitrified mass the rock is termed a quartzite. It looks as if the sandstone had been altered and partially fused. In some cases these quartzites have a crystalline appearance, especially when feldspar occurs with the quartz. Sandstones are found widely distributed

over the State outside of the crystalline rock regions of the Hudson Highlands and the Adirondacks. And they represent all of the geological periods, beginning with the Potsdam, up to the New Red Sandstone. Following the order as given on page 8, the occurrences and localities may be noted briefly.

### **Potsdam Sandstone.**

This formation in narrow outcrops is seen in Dutchess county, bordering the Archæan rocks. Outcrops of limited areas are seen in the Mohawk valley at several points between Fonda and Little Falls. In the Champlain valley this formation has been a source of building stone at Fort Ann, Whitehall, Port Henry and Keeseville. North of the Adirondacks there are quarries at Malone, in Franklin county. The most extensive quarries of this sandstone are on the Raquette river near Potsdam, and in Hammond, St. Lawrence county. At the last named place the product is largely paving blocks and curbing stone, and is made out of a grayish-white, thin-bedded sandstone. The Potsdam rock occurs in moderately thick beds, and is a hard, compact stone of a pink to light buff shade of color. Some of it has a laminated structure and striped appearance. It is an excellent building stone, and is widely known and esteemed for its beauty and durability.

### **Hudson River Group.**

This group includes shales and sandstones. The latter are generally shaly or argillaceous. There are some localities where more siliceous or arenaceous beds are found. And these latter beds furnish the building stone. As is well known, the formation follows the Hudson River valley from the Highlands northward to Washington county and the valley of the Mohawk west, and then runs north-west in a broader belt across Lewis and Oswego counties to Lake Ontario. Owing to the shaly nature of the sandstone, the localities for quarries are few. They have been opened on the Hudson river at Highlands, nearly opposite Poughkeepsie, at Rhinecliff (Rhinebeck station), near Tivoli, on the river between Stuyvesant and Schodack, at New Baltimore and at Troy. In the Mohawk valley there are quarries at Aqueduct, in Schenectady, on Frankfort Hill in Herkimer county, east of Rome in Oneida county, and in the town of Orwell in Oswego county.

The Hudson river formation does not supply much, if any, stone to markets outside of its limits. And nearly all of what is quarried

in it is used in foundations and common wall work. Granites, limestones and other sandstones are taking the place of the stone from its quarries ; and some of these quarries are abandoned.

### **Medina Sandstone.**

Siliceous rocks, principally sandstones, predominate in this formation. They crop out in the flanks of the Shawangunk mountain in Orange and Ulster counties. In the western part of the State the Medina sandstone borders Lake Ontario from the Niagara river to Oswego, and thence continues in an eastward course through Oswego and Oneida counties nearly to Rome. In the Shawangunk range the red or brown-red sandstones occur with some gray-white sandstones and some shales. And excepting two or three very small quarries it is not a source of building stone. The stone is generally hard and is not easily dressed. In the western part of the State the sandstone is associated with shales and shaly sandstone. The mass is made up of quartzose sand in fine grains, cemented more or less strongly by siliceous and ferruginous matter. The prevailing color is a brown or brown-red, but gray-white and variegated red and white also are common shades. In texture the mass is usually fine-grained. The strata lie dipping at a small angle southward, and the stone is remarkably even bedded. At nearly all localities two systems of joints, at right angles to one another, divide the rock into blocks, which help the quarryman in his work. Quarries in this formation have been opened and worked at Fulton, Granby and Oswego in Oswego county ; at several points in Wayne county ; at Rochester and on Irondequoit creek and Brockport in Monroe county ; at Holly, Hulberton, Albion and Medina in Orleans county ; and at Lockport and Lewiston in Niagara county. The quarries at Hulberton, Albion and Medina are among the largest in the State. And the stone therein quarried has acquired a well-deserved reputation for rich color, its strength and its durability as a building material. And the name of the formation (from the town of Medina), has come to be used for all the product of the many quarries in it.

### **Clinton Group.**

The rocks of this group are mainly shales. Impure limestone and some sandstone also occur. They form the outcrop in a narrow belt of country from Herkimer county west to the Niagara river and bordering on the south the Medina sandstone. Sandstone has been obtained



from this formation in the southern part of Herkimer county, and at Clinton and at Higginville in Oneida county.

### **Oriskany Sandstone.**

This sandstone is generally too friable to make a good building stone ; and no quarries of importance are known in it.

The sandstones of the CAUDA GALLI and of the SCHOHARIE GRITS are either argillaceous, and therefore not durable, or too porous and loosely cemented to make good building material. No doubt, localities could be found where some of the beds may be compact and solid, and may be quarried profitably for local use. The MARCELLUS SHALE, a more shaly formation than either of them, has furnished stone for building at Chapinville in Ontario county.

### **Hamilton and Portage Groups.**

The rocks of these geological groups are shales, slates and sandstones. But there is so great a range in composition and texture that there are many varieties under each of these heads and an almost infinite gradation from one to another ; and no sharp lines of demarcation or division can be drawn. And the notes on the sandstones of the Hudson River group apply here also.\*

In the Hamilton group, and above it, in the Oneonta sandstone in the eastern part of the State, there is a great development of gray, hard, compactly aggregated sandstone, which is thin-bedded or can be split on planes parallel to the bedding, and which is known as flagstone. This variety predominates in the upper part of the Hamilton formation, and continues into the Portage, or its equivalent here—the Oneonta sandstone. In the central part of the State, where this group is recognized, in a belt south of the Mohawk valley, in Otsego, Chenango, Madison, Cortland, Cayuga and Seneca counties, the sandstone is more or less mixed with shale and slate in irregularly alternating strata. And olive, greenish and yellowish shades of color prevail. In the western part of the State—that is, in the belt, stretching from Seneca lake to Lake Erie—through Ontario, Livingston, Genesee and Erie counties, the olive and bluish-gray shales predominate, and the sandstone is not abundant nor of the best quality for a building stone.

The Portage rocks in the western part of the State have been divided into shales at the base ; then shales and flagstones ; and the Portage sandstone at the top. In the last division thick beds with

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\* See pages 15 and 16.

little shale are marks of this horizon. And the stone is generally fine-grained. The line of division between the Hamilton and the Portage cannot here be indicated geographically, and the quarries are placed in one subdivision under the heading as above. The outcrops have been, in general, indicated as running through the Hudson valley east of the Catskills, and turning west, in a broadening belt south of the Mohawk valley and through the central plateau region and the western part of the State to Lake Erie.

The number of quarries in this belt of Hamilton-Portage is large. The greater part of all the Hudson river flagging comes from it. And there are hundreds of quarries opened in Sullivan, Orange, Ulster, Greene and Albany counties. The Guilford and Oxford quarries are in it. In the lake region, the Atwater, Ithaca, Trumansburgh, Watkins Glen, Penn Yan and the Ontario county quarries are all probably in it. Going west, the Portage and Warsaw quarries belong in the Portage horizon.

#### **Chemung Sandstone.**

The Chemung rocks also are shales and sandstones principally, but the proportion of shaly sandstone appears to be greater than in the Portage; and they are more commonly thin-bedded, and on the weathered surfaces or outcrops are olive to brown shades of color. On account of this prevalence of the shaly and inferior sandstones there is less building stone obtained from this formation, excepting the common grades, which are quarried largely to meet local demands and supply the towns in the territory on the outcrop. The Chemung rocks occupy the southern tier of counties from Lake Erie eastward to the Susquehanna. Good building stone is obtained from this formation at Elmira and Corning. The Steuben county quarries are in it. There are small quarries in Allegany county also in it. Jamestown gets its stone in part from it. And small quarries have been opened in Chautauqua county at other points which are referred here. The Olean quarry in Cattaraugus may be Chemung.

#### **Catskill Sandstone.**

The Catskill group is developed in a great thickness of sandstones, grits and siliceous conglomerates in the Catskill mountain region, in Sullivan, Delaware, Broome, Otsego, Schoharie and Greene and Ulster counties. Much of the sandstone is coarse-grained and hard to dress; and oblique lamination and cross-bedding also are common, which make it work badly. Excepting for flagging, little of the

Catskill sandstone is quarried. The region has no large towns in it, and hence no large local markets which would call for any considerable amounts of building stone. There are, however, some good quarries, which are worked for flagging, chiefly, along the N. Y., O. & W. R. R. and the U. & D. R. R. lines in Ulster and Delaware counties; and in the Catskills in Greene county there are quarries in Lexington, Jewett, Windham, Hunter and Prattsville.

### **New Red Sandstone.**

The formation, which is known as the New Red Sandstone, or simply as the Red Sandstone, is limited to a small triangular area in Rockland county, between Stony Point and the New Jersey line. The sandstones of this formation are both shaly and arenaceous; and the varieties grade into one another from the fine, shaly beds to fine conglomerates. The prevailing colors are dark red to brown,—whence the term *brownstone*. The cementing material is largely ferruginous. The formation in its extension south-west in New Jersey, furnishes the brownstone of the Belleville and Newark quarries so extensively employed as a building stone in New York and the adjacent cities. The famous “Connecticut brownstone” and the Longmeadow sandstone of Massachusetts come from the same formation in the Connecticut valley. The larger and more important quarries in this sandstone in Rockland county are in the west side of the Hudson river, between Piermont and Nyack and near Haverstraw, in the eastern slope of the Torne mountain. The oldest quarries were opened first about a century ago; and they were worked extensively for many years. The principal market was New York city, and the stone was sold for flagging, house trimmings, common walls and rubble stone. As the quarries were convenient to navigation and near a great market the business was large, until other stone came in to compete successfully with it. And the quarries have been abandoned and their sites taken for villas and town lots, for which their value exceeds that of quarry ground. At present there are only two quarries at work, between Nyack and Piermont. They furnish flagstone and dressed stone for building. The quarries near Haverstraw are not worked steadily. There are small openings near New City, near Congers station and at Suffern, and probably at a few other places, but all of them do a local business.

In New York city and in the towns on the Monmouth county shore of New Jersey this stone is sometimes called “Nyack stone” or “Haverstraw stone.”



## 2. LIMESTONES.

Limestone is essentially carbonate of lime, but it always contains some additional constituent ; and the more commonly occurring impurities, or accessory matters are silica in the form of quartz, clay, iron and magnesia. And limestones are said to be siliceous, argillaceous, ferruginous, magnesian and dolomitic, according as they contain one or another of these constituents. Other foreign mineral matter may be found in them, and in places so as to give character to the mass. The texture also varies greatly. It may be coarse or fine crystalline, sub-crystalline, or amorphous, according as the crystals which make up the mass are larger or smaller, or are not recognizable by the unaided eye. The terms coarse-grained and fine-grained may apply when the mass resembles sandstone in its granular aggregation. And it may be hard and compact, almost vitreous, or loosely cemented and crumbling with slight pressure like sugar, or, again, like chalk, dull and earthy. From this general statement of the range in composition and texture, it follows that there is an equally wide variation in the hardness, strength and durability of limestones. Some are hard and strong, surpassing in their resistance to crushing force, many granites, and nearly as durable as the best sandstone ; others are friable and fall to pieces under slight pressure, or they are dissolved rapidly by atmospheric agents. Wherever the admixture of silica is large and the texture is compact, the stone is hard and durable ; hence the siliceous limestones are generally among the most enduring building stones. The magnesian and dolomitic varieties also are good stone. In color the prevailing shades are grey-blue, and yellow to white. As stated on a previous page, the limestones which are quarried for building stone in this State are found in the following named formations : Calciferous, Chazy, Trenton, Niagara, Lower Helderberg, Upper Helderberg or Corniferous and Tully limestones. The geographical distribution of the several limestone formations is here given in the same order—that of the geological succession, beginning with the Calciferous sandrock.

### Calciferous.

Although termed a Calciferous sand-rock, very much of the rock thus designated is, properly, a magnesian or a siliceo-magnesian limestone. Some of the blue limestone which is quarried in Orange county and the New Hamburg quarry in Dutchess county are probably of this epoch. The calciferous is traced along the Mohawk



valley, in Montgomery, Herkimer and Oneida counties. The quarries at Little Falls, Canajoharie and other smaller openings, are in it. The Sandy Hill quarry also is apparently in the same horizon. Generally the stone of this formation is in thick beds, siliceous, hard, strong and durable.

### **Chazy Limestone.**

The Chazy formation is seen in Clinton county in its typical locality. It is non-magnesian and less siliceous than the Calciferous. The beds are thick and often uneven. Regular joints are common, dividing it into rectangular masses and helping the quarrymen in extracting the stone. It affords strong and heavy stone at quarries in the Champlain valley, at Willsboro Point and near Plattsburgh.

### **Trenton Limestone.**

The Trenton here includes the Birdseye, Black River and Trenton formations. And it occupies the Mohawk valley, the Champlain valley, a border zone around the south-western and western sides of the Adirondack region, and the St. Lawrence valley, from the Canada line south-west to Lake Ontario. The counties of Montgomery, Fulton, Herkimer, Oneida, Lewis, Jefferson, St. Lawrence, Hamilton, Clinton, Essex, Warren and Saratoga have outcrops of limestones which are referred to the Trenton age. Many quarries in the Mohawk valley; the quarries at Prospect and Holland Patent in Oneida county; Lowville in Lewis county; Watertown, Chaumont and Three Mile Bay in Jefferson; Norwood and Ogdensburg in St. Lawrence; and Glens Falls are opened in these limestones. There is much variation, from the dark-colored, compact marble of Glens Falls to the gray, fine-crystalline stone of the Prospect quarries. And these variations are often seen in vertical sections of comparatively few feet, so that the same quarry may yield a *marble* and a coarse, rough stone fit for common walls only. Hence no general description is applicable to the formations as a whole; and it is impossible to assign all of the quarries to their proper horizon. In fact, in some of the quarries two formations are represented.

### **Niagara Limestone.**

This formation has its great development near the Niagara river and the Lockport and Rochester limestone quarries are in it. At Lockport it is a gray, thick-bedded, sub-crystalline stone, which has been used widely for building.

### **Lower Helderberg Group.**

This group includes a wide variation in its limestones, and no general statements apply to the several horizons alike. The formation is traced from the Helderberg mountains westward, south of the Mohawk river nearly to Syracuse. The lower beds (Tentaculite) are dark-colored, compact, thick, and afford a stone which can be polished. The Pentamerus limestones, in the upper part, furnish a gray, heavy-bedded and strong stone, which answer for heavy masonry. Quarries in the Lower Helderberg group are opened in the Schoharie valley at Cobleskill, Cherry Valley and in Springfield, Otsego county.

The quarries near Hudson, in Becraft's mountain and the quarries near Catskill also are in it.

### **Upper Helderberg Group.**

Under this head there are building stones in the several limestone formations. Of these the principal are the Onondaga and Corniferous and the Seneca blue limestones. The noted "Onondaga gray limestone," of Onondaga county, belongs in this group. The Union Springs, Waterloo, Seneca Falls, Auburn, Le Roy, Williamsville and Buffalo quarries are Upper Helderberg. The Kingston, Ulster county, limestone also belongs here.

There is a great diversity in the limestones which are quarried in these localities and from this geological group. The Onondaga gray limestone is coarse-crystalline, and contains coralline fossils; and makes a beautiful stone for fine cut ashlar work or for ornamental and decorative uses. The cherty or corniferous beds are dark-colored, hard, and do not dress well, and answer for common work only. The Seneca blue limestone dresses well and is a fairly good building stone.

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As a supplement to the limestones the quarry in calcareous tufa at Mohawk, in the Mohawk valley, should here be mentioned, although the quarry is of no importance and there is no great outcrop for much work in it.

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It is proper to refer to the division of Fragmental Rocks, the stone which occur in the Quaternary formation, particularly and chiefly in the Glacial Drift. This drift is found in all the counties of the State and in nearly all of the towns, overlying the older rocks. But it is unimportant as a source of building stone at the present time. In the earlier history of the country many stone buildings were constructed

of the stone found lying on the surface or in the surface earth. They are sometimes called "field stone." Having been transported many miles and been subjected to great wear, they represent the more resisting and harder rocks. They are generally more or less rounded and scratched or furrowed. Geologically they are known as *boulders*. On Long Island they are the only stone to be had. And some of the older houses on the western end of the island are built of sandstone obtained from the drift. Others are of sandstone, trap-rock and gneissic rock, mixed. In grading and cutting down the hills in Brooklyn enough stone is sometimes found to lay the foundation walls. Of course the drift includes the harder sandstones, quartzites and gneisses mainly.\* At Medina, in uncovering the sandstone transported blocks occur in the stripping or drift. But this formation cannot be considered as a source of any regular quarry business, though, in the further clearing up of the country, it may yield a great deal of stone for the localities where it occurs.

### Slates.

Slate is used to designate compact, fine-grained rocks, which have the property of cleaving into thin plates. The term rests for its signification upon a physical property rather than upon chemical or mineralogical composition. Hence there are many varieties from the argillaceous (clay-slate, or *argillyte*), to hornblendic, chloritic and hydromica slates or schists. But nearly all of the slate which is employed either as constructive or as decorative material belongs to the argillaceous variety, *clay-slate*. It is a sedimentary rock and occurs associated generally with sandstones and other fragmental rocks. Since the great use is for roofing material, it is often called *roofing slate*. The prevailing colors are gray to blue-black; purple, red, green and variegated (red and green), are less common shades. There is much variation in the degree of hardness, and some are very hard and also brittle. The fineness of grain, or texture is another mark of difference in slates. Generally the rock which is more highly metamorphosed, is stronger and more fissile, and hence a more durable material. The direction of the cleavage may coincide with that of the dip of the bedding planes, or it may be oblique to them. For use as roofing material, the color, fineness of grain, strength, hardness, freedom from pyrite or seams of calcite and quartz, and durability are essential qualities.

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\* At Yonkers the trap-rock boulders have been used largely in the building of retaining walls and foundations.



The Hudson River group in New York, is characteristically a slate formation. It occupies the Wallkill valley in Orange county, the valley of the Hudson river from the Highlands northward to Saratoga and Washington counties, and the Mohawk valley west, and thence a belt north-west to Lake Ontario. Slates of the Cambrian age are recognized east of the Hudson in Washington and Rensselaer counties, near the Vermont line. It is not known that any of the *slaty* rocks of the other geological formations in the State yield slate of economic importance. Roofing slate has been sought after in very many places within the bounds of these formations and quarries, which have been more or less productive, have been opened in Orange, Dutchess, Columbia, Rensselaer and Washington counties.\* At present, the productive quarries are all in Washington county, and are limited to a narrow belt which runs from Salem north-north-east, through the towns of Hebron, Granville, Hampton and Whitehall. There appear to be four ranges or belts ("*veins*" of quarrymen) first, on the west, the East Whitehall red slate; second, the Mettowee or North Bend red slates; third, the purple, green and variegated slates of Middle Granville, and on the east, near the Vermont line, the Granville red slates. These quarries of Washington county produce a large amount of colored slate for decorative and ornamental work, and all the red slate which is quarried in our country, comes from this district.†

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\* See MATHER'S REPORT on the First District, pp. 419, 421.

† The line between Vermont and New York runs so as to separate the red and sea-green slates, and all of the former are in New York, while all of the latter are in Vermont.



## DESCRIPTIVE NOTES

— OF —

# Quarry Districts and Quarries.

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### I.—CRYSTALLINE ROCKS.

#### *GRANITES, SYENITES, GNEISSES, MICA SCHIST.*

Beginning at the south, with the quarries in rocks of this group, the NEW YORK or MANHATTAN ISLAND gneisses have afforded a large amount of stone for common building work. These gneisses are mostly of the micaceous variety; and they are found in thin beds, dipping at high angles generally and to the east-south-east or west-north-west. Owing to the large percentage of mica they are not so strong and durable as the true gneisses and granite; and are apt to flake off and disintegrate on long exposure. Some of the more feldspathic beds and the granitic veins and dikes afford a stronger and better material. But the general mass is at best of an inferior character. The excavations for streets and the grading of hills has yielded a very large amount of stone for foundations and inner walls. The Forty-second street reservoir is an example of the best of the island gneiss. St. Matthews's Lutheran Church, Broome street, is another.

FORDHAM, WESTCHESTER COUNTY.—St. John's College has a quarry on its property nearly a half mile east of the college, and on the corner of the Boulevard and Pelham avenue. There are two openings, of which the larger, measures, approximately 140 feet by 50 feet and 25 feet deep. The strata dip  $82^{\circ}$  to  $86^{\circ}$  S.  $65^{\circ}$  E. The stone is a micaceous gneiss, consisting of brown-black mica in laminæ, parallel with the bedding and alternating with quartz and feldspar. It has a bluish-gray shade of color, and hence is known as "blue-stone." Owing to the mica the stone splits readily in planes parallel to the bedding, and is squared easily into blocks for heavy walls. And blocks 25 feet long, 6 feet wide can here be obtained. There is no water

to be raised, and the quarry is worked to advantage on account of the little *stripping* and the ease with which the rock can be split. The two new buildings of the college are built of this "bluestone," dressed and laid in course work.

Another quarry in the micaceous gneiss is seen at the south side of Pelham avenue, near the College quarry, but it is small and not worked to any extent.

HARTSDALE, WESTCHESTER COUNTY.—Near Hartsdale station, on the Harlem railroad, a gneiss rock is quarried for the local market. It has been used at White Plains in the court-house and jail buildings, and in the bank building near the court-house, and also in a church. The stone is substantial and durable, but rather unsightly, on account of some of the weathered, rusty, reddish-brown blocks, due to iron stains.

Gneiss rock is quarried south-east of White Plains; and it can be seen in the Methodist Episcopal church on the main street. It does not show the same iron stains as the Hartsdale rock.

SCARSDALE, WESTCHESTER COUNTY.—Several openings, which are known as the Seely quarries, are to the west of the road to Greenville and on the ridge, a half a mile west-north-west of the Scarsdale railroad station. The main opening is at the south-east and near the corner of the road. It is about 80 x 25 feet and 5 to 18 feet deep. The rock is gneiss, thick-bedded and grayish in color. The strata dip 72° north, 57° west. The smaller openings are west and north-west of the main one, and between them the same massive bed of rock is exposed and having the same dip of its strata. The principal minerals of the rock are quartz, feldspar and a little black mica, and these minerals in parallel lines and layers give the gneiss a foliated structure. The exposed ledges near the quarry show very little alteration due to weathering; and are firm and solid, indicating a strong and durable stone. Blocks of large size, up to 40 feet in length and 15 feet wide, have been taken out. The plant consists of one engine, one derrick and two steam drills. There is no water. Stone from this quarry has been used for bridge work for the Bronx River aqueduct, and also for the Williamsbridge Reservoir gate-house. The stone seems specially adapted for heavy work. The quarry is worked at intervals according to the demand, and the stone carted by team to the railroad station.

HASTINGS, WESTCHESTER COUNTY.—Gneiss rock has been quarried on the river bluff, one mile south of the railroad station at Hastings. The bluff has been worked back to an height of 40 feet and a length of 250 feet. The strata dip  $75^{\circ}$ , in an east-south-east direction. One system of joints runs with the strike, north  $35^{\circ}$  east and dips about  $15^{\circ}$  to the north-west. A second system runs south-east and is vertical. A third system runs in a south-easterly direction also, but dips at a moderate angle to the south-west. The beds at the south end are thick, and stone of large size can easily be obtained. The more westerly beds, which are at the north end of the quarry, are more schistose and thin. The stone is hard to cut, but splits straight in the planes of the beds. The thick beds afford large blocks for bridge work. The thin strata are worked up into common wall stone and foundations, and these latter are quarried by individuals at intervals. The quarry is owned and worked by the New York Central Railroad Company, but is not constantly in operation.

HASTINGS.—What is known as "*Munson's quarry*," is three-quarters of a mile east-south-east of Hastings. It is the property of Wm. G. Lefurgy. And it was first opened in 1850. The opening is at the south-west end of a high, rocky ridge of micaceous gneiss, whose beds dip at an angle of  $70^{\circ}$  to the south-east. It runs about 300 feet into the hill, and has an average width of 100 feet. The bedding is very regular and even, and the beds are nearly all thin. The rock is a biotite gneiss, which has a gray and striped appearance, due to alternate, thin layers of black mica and thicker layers of feldspar and quartz. It is fine crystalline. It is readily split in planes parallel to the bedding or broken crosswise, if not shattered by blasting. There is no water to be pumped, and there is no machinery other than a hoisting crane. The stone is carted to the river. The larger stone is shipped to New York city for foundation walls; the smaller blocks are used for common walls; and some is cut into curbing. The glaciated, outcropping ledges at the north of the quarry show little signs of weathering. From five to fifteen men are employed steadily in the quarry.

J. N. Ferguson's quarry is on the same ridge, and about 80 rods to the north-east. It has been opened three years. The beds dip at an angle of  $70^{\circ}$  to the south-east. The stone resembles that of Lefurgy's quarry. The beds are from 6 to 12 inches thick. And the adjacent outcrops are a proof of the durability of the stone



when exposed to the weather. The stone is carted by teams to the dock at Hastings, whence it is shipped for foundations and building generally.

**YONKERS.**—Valentine quarry. This old quarry consists of two small open cuts on ledges, which crop out in front of the Valentine house, on the top of the hill, two miles south-east of Yonkers and on the Mount Vernon road. The openings are only a few rods long, and not over 12 feet in depth, and about 20 yards wide. The strata stand on edge and their strike is north  $55^{\circ}$  east. The stone of this quarry is a grayish-black, striped mass. The quarry has not been worked of late years.

**TARRYTOWN.**—The old Beekman quarry is on lands of A. C. Kingsland, one and a quarter miles north of Tarrytown, and at the east side of the railroad track. It was worked largely in former years; latterly, the quarrying of some stone for building walls is all that is done. The quarry has a length of about 800 feet; a breadth of 80 to 160 feet, and, at the back, is 50 feet deep. The strata dip  $55^{\circ}$  to  $80^{\circ}$  south,  $65^{\circ}$  east. There is much variation in the rock. Some of it, at the north end, is schistose and thin-bedded. The stone, which is quarried, is a massive-bedded, granitoid gneiss, gray to flesh-colored; and hard and compact, although easily dressed. Blocks of large size can be obtained. Being above the tide level and conveniently located on railroad and river, this quarry has advantages for working.

**KENSICO, WESTCHESTER COUNTY.**—On the east side of the Bronx River reservoir at Kensico, north-east of the dam, and a quarter of a mile from the station, gneiss has been quarried extensively for the construction of the reservoir dam and for local use. The opening at the side of the reservoir has a face 50 feet high and a total length of 600 feet from north to south. The beds dip  $30^{\circ}$  to  $40^{\circ}$  north,  $60^{\circ}$  west. The stone is a granitoid gneiss, in thick beds, of gray color. Back of it and lying upon it are thin beds of schistose rock, which is valueless as building stone. There are two main systems of joints; one runs north  $45^{\circ}$  west, and the other north  $65^{\circ}$  west. A third system of joints dips about  $40^{\circ}$  east-south-east, and runs nearly in the course of the strike of the beds, *i. e.*, north  $30^{\circ}$  east. These seams or joints break the mass into blocks of large size. The disadvantage at this quarry seems to be that the thick bedded gneiss is confined to a narrow belt in the more micaceous and schistose rock.

UNION VALLEY, PUTNAM COUNTY.—The quarry of Jackson & E. Ganung. These quarries are four miles, by the road, from the town of Croton Falls, and a half a mile south of Union Valley, in the town of Carmel. They are small. The beds dip  $75^{\circ}$  to the north-west. A prominent joint system runs east and west, dipping about  $80^{\circ}$  north; somewhat wavy in its course. The stone has a striped appearance, due to black mica and white feldspar alternating in thin layers, from one-eighth to half an inch thick. The main use of this stone is for posts and foundations. Some of it has been used for monuments and a little for buildings also. A good example of it can be seen in the house of Mr. Todd, one mile south-west of Croton Falls. The quarries are worked irregularly and for local market. The stone is durable, as shown by the weathered ledges in the quarry, but it is not capable of being polished, and when dressed and rubbed it has a wavy and striped appearance, which is not altogether pleasing to the eye.

RAMAPO, ROCKLAND COUNTY.—A gneissic rock is quarried south of Ramapo village on lands of Henry L. Pierson. The quarry is in the steep face of a low ridge—and about fifty rods west of the line of the N. Y. L. E. & W. R. R. The hill side has been worked to a height of nearly one hundred feet above the valley level at the east. The rock is a syenite gneiss or hornblendic granite and is so massive-bedded that the stratification is not plain. A well-marked joint system has a course of few degrees north of west and dips steeply southward. A second system of joints runs vertically, south. The stone is red flesh-colored. It splits *true* and is not difficult to dress for heavy, squared masonry, for which it is specially suited on account of its strength, durability and the large size of blocks which can be obtained. The quarrying is scarcely more than the throwing off by large blasts of great masses of the stone which are subsequently broken up into desired sizes. A little of this stone has been used for monumental work. The stone for the Hon. Abram S. Hewitt's house, at Ringwood, N. J.; and for some of the Erie railroad bridges is said to have come from this quarry. The place is easily worked, as there is no water, and no hoisting as from a quarry in excavating, and it is convenient to railway.

Over the hill to the west, and near the New Jersey line a granite quarry has been opened by John L. Rowland, and a little stone taken out. Blocks of large size can here be obtained, but owing to the hilly road and the distance it is not worked to any extent.

SUFFERN, ROCKLAND COUNTY.—Granite for cemetery posts and for monumental bases has been quarried for years past from the side of the ledges a quarter of a mile west of Suffern station and at the side of the Ramapo road. The stone is greenish-gray in color, but weathers to a reddish-brown cast. It is hard to cut and dress, but is durable. A very little of it is used by Wm. Copeland, at Suffern, for cemetery work.

PEEKSKILL.—Hudson River Granite Company's quarry. This company is opening a granite quarry on a rocky ledge about two miles north-west of Peekskill and east-north-east of Iona island. It is on the land of the Van Cortlandt estate. The entire point, which is pierced by a railroad tunnel, is almost bare of soil and earth; and an immense mass of solid rock is in sight. Its slightly weathered surface indicates the durability of the stone, and the absence of bedding planes will enable the quarrymen to get out large blocks. The stone is gray — flesh-colored, medium fine-crystalline and consists of feldspar, quartz and hornblende. The parallelism in the arrangement of the minerals shows the *grain* of the stone to dip steeply, east-south-east. A track has been built from the quarry, down on the slope of the hill to the river, where there is a dock. The chief product is to be paving blocks.

WEST POINT.—West of the academy buildings and on the side of the hill gneiss rock has been uncovered and quarried for the construction of the Government buildings. The most southern quarry is south-south-west of the Observatory, and a quarter of a mile from it. The rock is a biotite gneiss. It dips  $40^{\circ}$  to  $50^{\circ}$  S.  $75^{\circ}$  E. The opening is 100 feet long, 40 feet wide and about 18 feet deep. A second opening is 150 yards north-west and is 150 feet by 75 and 15 feet deep. The rock here is rather more massive-bedded and gray in color. The beds dip  $38^{\circ}$  E. SE. North of Fort Putnam and west of the Academy there are three almost connected openings, and within 200 feet of the road. The bedding of these quarries is not so plain as in the more southern openings. The dip is  $25^{\circ}$  to  $30^{\circ}$  E. SE., and the rock shows a pitch to the NE. at an angle of  $25^{\circ}$ . The rock is fine-crystalline and hard; and the ledges about these openings are a proof of the durability of the stone. North of the last described locality is an older quarry, and about 100 feet west of the road and a half a mile north-west of the Academy. Its extent, from east to west, is about forty yards, north to south thirty yards, and it



is ten to twenty-five feet deep. The dip is 20 to 25° S., 70° E. One system of joints runs vertically SE.; a second S. 70° E. and dipping 75° S. SW. The rock is a hard, solid, thick-bedded, granitoid gneiss, with little mica. The firm outcropping ledges about these quarries show the durability of the stone where exposed to the weather. The library building, and the old riding academy, and three of the professorial residences, as well as long lines of retaining walls, are constructed of the native rock from these quarries. The quarries and these examples of the use of gneiss in the Highlands are instructive and suggestive of other localities for opening such stone, and for its use where strength and solidity are wanted.

**STORM-KING MOUNTAIN QUARRY.**—Granite has been quarried from the south-east face of Storm-King mountain, near the West Shore railroad track, and a half a mile south of Cornwall station. The property is owned by M. C. Lawrie of New York. Great masses of rock have been thrown down by blasting, and subsequently broken up for building stone and into paving blocks. This stone has been used in buildings in New York city, and also in Washington, D. C. The cliff is about 100 feet in vertical height above the railroad track. The location is convenient to both the railroad and the water, and there is no pumping or hoisting as is necessary in the excavation from a quarry. The stone is a gray, moderately coarse-crystalline mixture of feldspar, quartz and a little mica. Its durability is attested by the scarcely weathered surfaces of the exposed ledges of the face. The locality has not been worked for several years.

**BREAKNECK MOUNTAIN QUARRY.**—Granite has been quarried at several points on the south side of this mountain and north of Cold Spring. It is at least sixty years since the locality began to be worked. And at long intervals quarrying has been carried on up to the present time. These quarry sites extend back nearly a mile from the river. The work has been to detach blocks of large size by blasts, and then to break them up into convenient sizes for building stone or into paving blocks. The present quarry is on lands of Lewis J. Bailey, and is worked for both building and paving stone, the latter by William V. Smith of New York. And a crusher breaks stone for roads. The quarry is at the east side of the railroad, and extends up the mountain side to a height of 500 feet. The stone are shipped by boats at dock on the property. The stone is a gray to gray-white, coarse-crystalline hornblendic granite.

**LITTLE FALLS.**—Gneiss, or, as it is here known, the “blue rock,” has been used a great deal in Little Falls, on account of its numerous outcrops and the necessary openings in it for the construction of the Erie canal, the New York Central railroad, and the excavations for buildings. No regular quarries have been opened; nor is it exported for construction elsewhere. The rock has a greenish-gray shade, and is moderately fine-crystalline in texture. It is hard and a durable building stone, as can be seen by the ledges outcropping in the valley and in the old structures and walls built of it. The stone was used in several mill buildings, in the R. C. church, in the new school, in the Presbyterian church and other buildings in the town.

**WILTON, SARATOGA COUNTY.**—Granite is quarried in the town of Wilton, two miles north of Saratoga, on the eastern slope of a gneiss rock ridge, and about 80 feet above the plain. The opening is in the face of a south sloping ledge which rises 100 feet or so above the quarry. The beds are thick and dip about 40° south-south-west. The rock is divided by a joint system, which runs north-north-east, and dips steeply east-south-east. The bed which is now worked is about 15 feet thick. The opening has a breadth of about 100 feet and is about 60 feet deep. The plant of the quarry consists of one derrick, and a shed for dressing. The stone is light gray in color, and is plainly stratified; and in places shows lines of black mica which are in sharp contrast with the white quartz and feldspar; and it is rather fine and crystalline. Some red garnet is present in small nodular masses. The stone can be split with the *rift* or grain of the mass. It is hard, but dresses *true* and readily. The weathered ledges all about the quarry show that it is very slightly affected by long exposure. One objection to this stone for building purposes is the garnet which gives the mass a brown, and in some cases a spotted appearance, which is not pleasing. Very little of it has been used as building stone. The greater part of the product has gone into paving blocks, some of which have been laid in Albany, some in Cohoes and other places. The quarry is one mile from the D. & H. C. Co.'s railroad station, and the stone is shipped over that line. The quarry is worked by A. N. Brady, of Albany.

North-west of the Wilton quarry granite has been worked in the town of Greenfield, but only to a limited extent. The quarries are now idle.

Granite has been quarried at the side of the Adirondack railway near Wolf Creek or Quarry Switch, as the place is now known. The

property is owned by George Marks, of West Troy. The opening is a few rods west of the railroad line and a little way up on the point of the ridge. The stone is properly a gneiss rock. It was worked for a time, and some of the stone was sent to Albany for the new capitol foundation.

ADIRONDACK GRANITE COMPANY, WESTPORT, ESSEX COUNTY.—A granite quarry was opened in 1881 on the shore of Lake Champlain and on the Splitrock tract, by the Champlain Granite and Marble Company. Very little work was done that year. The locality was reopened in 1887 by the present company. The quarry is reported to be one-third of a mile from the wharf in Barron Rock bay and at an elevation of 500 to 600 feet above the lake. The specimens submitted to Prof. Hall in 1881, were reported by him to contain labradorite, hornblende, quartz and a small proportion of dark-brown mica.\* The stone is said to receive a good polish, and a monument in the Middlebury, Vermont, cemetery shows that it retains the polish. The quarry is two and a half miles from the line of the D. & H. C. Co.'s N. Y. & Canada railroad.

AU SABLE GRANITE, ESSEX COUNTY.—The quarries of the Au Sable Granite Company are on the north slope of Prospect Hill, one and a half miles south of Keeseville, and in Essex county. There are two openings, a little more than 100 yards apart. They were made in ledges whose surfaces were glaciated. The lower quarry is to the northward, and has a maximum depth of 20 feet. The joints which appear in the rock at this place are smooth and irregular. One runs south  $55^{\circ}$  west. The others are not so regular. Another system of joints runs south  $10^{\circ}$  east. The rock at this quarry is coarser in crystallization than that of the upper quarry. The mineral composition is labradorite, hornblende, quartz and here and there a scale of brown mica. The weathered rock has a light-gray shade, due to the alteration of the feldspar in the long ages since the close of the glacial epoch.

The upper quarry is about twenty rods south  $10^{\circ}$  west of the lower, and is at least 100 feet higher up on the hill. The original surface was steeply sloping north-west, and the earth covering was thin. One main set of joints is vertical, and runs south  $40^{\circ}$  west. A second one dips in the same direction. A third has a south-easterly

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\*Report to company in their circular.



course, and dips steeply north-east. These joints or seams are usually from four to six feet apart, hence the blocks as made by these joints are large. This subdivision of the rock facilitates the quarrying of large masses, which are afterward broken into sizes by means of plug and feather wedges; and very little powder is used, as there is no blasting except to throw off the surface stone. The joints also help in the working into the hillside east and south and upward.

As the quarries are on the side of the hill, and are not yet deep, there is need of very little pumping. There is one derrick for hoisting stone at the lower quarry and one at the upper quarry. At the upper quarry a track runs from the quarry to the dump where the waste rock is thrown out. All of this stone on the dump would answer for ordinary building purposes, but owing to the lack of a local market it is practically useless.

The glaciated ledges, with their rounded, grooved and polished surfaces, near the quarries on this side of the hill, both above and below them, show very little alteration by exposure to the weather; and the durability of the stone is proven by the very slight tendency to alteration in these surface outcrops. The quantity of stone is apparently unlimited. The distance to the railroad or lake at Port Kent, which is the nearest point to rail or boat, is the only serious drawback, as all of the stone has to be hauled by teams to that point or Douglass station. The company has its dressing and monumental works in Keeseville, and the product goes into market, dressed. On account of its hardness and the cost of dressing, the Au Sable granite cannot compete with limestones or sandstones for common wall work, but for decorative or monumental work it is especially adapted, because of the high polish which it receives and its beauty. The dark, polished surface, with its chatoyant play of colors, is both beautiful and pleasing, in contrast with the substantial-looking, gray, dressed surfaces. And lettered work is thus sharply defined in the dark ground.

This granite has been used for interior decoration in a church in Philadelphia. It is being put into the trimmings of the Y. M. C. A. building at Burlington, Vermont. For monuments it has had a wide market.

Another quarry is opened in the granite on this (Prospect) hill, about a quarter of a mile south-west of the Au Sable Granite Company's openings. It is idle.

One mile west of Keeseville, Clinton county, the granite has been opened by a Glens Falls party.

GRINDSTONE ISLAND, JEFFERSON COUNTY.—A red granite is quarried extensively on this island in the St. Lawrence river, north-west of Clayton. There are many outcrops, especially on the western side of the island; and small quarries have been opened at more than twenty different points. Three of them are large and worthy of notice here.

GORDON'S QUARRY is about a half a mile from the north-west side of the island. There are two openings, at the east and west ends respectively, of a low, rocky ledge, which rises twenty feet above the surrounding surface and sixty feet above the river. On the west paving blocks are made; on the east a large part of the stone goes into buildings. The vertical joints run nearly north and south, and are used in blasting apart the great blocks of stone. Afterwards these blocks are split by plug and feather wedges. As the stone splits *true*, and blocks of large, rectangular shapes are readily got, it makes an excellent heavy-wall stone. And it is used for massive foundation work. The stone is red and coarse-crystalline. It is worked for the International Granite Company of Montreal. The stone are shipped by boat down the St. Lawrence.

THE CHICAGO GRANITE COMPANY'S QUARRY is on a north-west facing hill side, about 1,000 feet from the bay and river, and in a great rounded ledge of rock. The excavation has a length of 100 yards from north to south, and at the most is not more than forty feet in depth. It is all above natural drainage. The seams or joints, dividing the rock, appear to be irregular and not continuous. The stone splits most readily in planes which dip to the eastward. It is red, mostly coarse-crystalline, but varies in texture from point to point. Imbedded and rudely spheroidal masses of a gray, granitoid rock, of much finer grain, occur in the red granite, and are here known as "knots." This quarry has been opened for five years. The output has been nearly all in the form of paving blocks, and has been sold to western cities. A tramway, 1,000 feet long, connects the quarry with the wharf, at which there is a mean depth of twelve feet of water.

THE THOUSAND ISLAND GRANITE COMPANY'S QUARRY is on the point of a rocky promontory which projects north-west into the river, and is on the northwest side of the island. It is at least a quarter of a mile east of the Chicago company's quarry, and is in a rocky knob,

which was originally bare, and at an elevation of sixty-two feet above the river. Vertical joints traverse the rock in two directions; north  $35^{\circ}$  west, and north  $35^{\circ}$  east. The first are known as "headers," and the latter as "grain seams." And the rock splits more readily in lines or planes parallel to the latter. The stone is coarse-crystalline, bright red in color, very hard and strong.\* Its mineral constituents are feldspar, quartz, brown-black mica, hornblende and some calcite. Scattering crystals of pyrite are seen in places, with hornblende. "Knots" of the red-gray, gneissic rock, occur here also, imbedded in the red, coarse-crystalline matrix. Its durability is witnessed by the unaltered or scarcely altered rock, which is exposed on all sides of this rocky promontory. It breaks readily into sizes for paving blocks. In the process of quarrying the practice is to put in deep holes, and with a large blast throw out great masses of rock, which are then worked up into building stone and paving blocks. Blocks twenty feet long, six by six feet, are readily obtained. In fact, the limit in size is the shipping capacity and the means for handling. Three quarry derricks and one loading derrick are worked by steam. Tracks run from the quarries to the dressing levels, and then to the dock. There is eighteen feet depth of water at the dock. The greater part of the product of this quarry is shipped to western cities, principally Cincinnati and Chicago; and mostly for paving streets.† A great deal is shipped to Montreal for monumental work and for building stone. The price ranges from \$1.00 to \$2.00 per cubic foot, in sizes under 20 cubic feet. The waste is used at Montreal for granulyte pavement. The stone from this quarry can be seen in the columns in the Senate chamber of the new capitol at Albany. They were quarried at the end of the bluff, and not far from the original surface. At present the workings are deeper, and the stone is better. This quarry has been opened seven years. The granite is apparently inexhaustible.

All of the stone from these quarries on Grindstone island is shipped by boat to Chicago, Toledo, Montreal or other points of destination.

### MARBLES.

NEW YORK CITY.—The white limestone was quarried for marble on Manhattan island near Kingsbridge, and used in the construction

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\*The resemblance to the Scotch granite, has given the name of "International Scotch granite" to this stone.

† One million paving blocks were sold last year (1887). And 100 to 120 men are employed all the year.



of buildings, but nothing has been done there for a long time. The stone is impure and somewhat crumbly on surface ledges, and is not a good marble.

At Morrisania some stone has been quarried for bridge construction; also at Mott Haven, both in the white or yellow-white crystalline limestone, but they cannot be called marbles in a proper sense.

AT TREMONT (WESTCHESTER COUNTY), St. John's College owns a marble quarry on Third avenue. The dip of the strata is  $66^{\circ}$  to  $70^{\circ}$  S.,  $60^{\circ}$  E. One prominent joint system runs N.  $20^{\circ}$  W. and dips  $80^{\circ}$  S.  $70^{\circ}$  W. A second system dips a few degrees north-west. The stone is a white, crystalline marble, and was used in trimmings for St. John's College. Its contrast in color with the dark-blue gneiss in the college buildings is striking and effective. This quarry is worked for the college work, and not for the public market.

A white marble was formerly quarried on the east side of Washington avenue, and near One Hundred and Seventy-eighth street and Tremont. The strata here dips  $80^{\circ}$  S.,  $55^{\circ}$  E. The opening is only about 100 feet long, 50 feet wide and 15 feet deep.

The quarry of Caleb Hillman is on the south side of East One Hundred and Seventy-eighth street, between Third and Madison avenues. The rock has been opened for a length of 200 feet on the strike of the beds and about 60 feet in width. The dip here is  $80^{\circ}$  S.,  $57^{\circ}$  E. The opening is not over 10 feet deep. The stone obtained is white and fine-crystalline. Some of the bed faces show a little yellowish mica, and in some parts of the beds a white tremolite is observed. The quarry was opened thirty years ago.

North of this quarry of Hillman's a few rods is another and older opening which is 200 feet long by about 15 feet in depth, running from One Hundred and Seventy-ninth street southward. This latter quarry is not now worked. Hillman sells marble for steps, lintels, etc., and for house trimmings. There is no water and no machinery is used.

These marble quarries in Tremont are worked irregularly as the demand calls for the stone, and the output in the aggregate is comparatively small and unimportant.

TUCKAHOE, WESTCHESTER COUNTY.—The marble quarries at Tuckahoe are opened in a depression or narrow valley at the eastern foot

of a low ridge and east of the Harlem railroad. They are in a line from north-north-east to south-south-west, and between a quarter of a mile and one mile from the Tuckahoe railroad station. The crystalline limestone makes a narrow belt between the mica schists which bound it on the west and on the east sides. And its beds appear to be conformable with the schistose strata.

The north-eastern quarry is on land of the Stewart estate. The quarry was partly filled with water when visited, and the outcropping strata and upper part of the walls alone were then seen. The dip of the beds is  $70^{\circ}$  N.  $60^{\circ}$  W. The stone is white to bluish-white, coarse-crystalline, and contains some scattering, small scales of white mica. On the joint faces tremolite crystals are common. This quarry has been idle for twenty years, and the mill at the south side of the quarry is in ruins. The marble in the Stewart mansion, Fifth avenue and Thirty-fourth street, New York, was got here.

About 100 rods south-west of Stewart's quarry is that of ——— Youngs, which is 200 yards long on a line with the strike, and 100 feet wide, opposite the mill, and 30 feet wide at the south end and 40 feet deep. The beds dip  $75^{\circ}$  N.  $55^{\circ}$  to  $60^{\circ}$  W. The stone is white, and rather coarser-crystalline than that of the Stewart quarry. The association of the marble and the foliated, schistose gneiss on the west side of the quarry is interesting, and the two rocks are seen almost in contact and have the same regular dip to the west-north-west. At the west side of the quarry there is a substantial marble mill with six gangs of saws, and two large derricks stand on the same side of the quarry. This quarry was idle the last year.

The New York Quarry Company (J. M. Masterton) owns the next quarry to the south. And it the largest of the Tuckahoe quarries. When visited a part of it was filled to a depth of 60 feet with water, and above it the sides were about 60 feet high on the west and 20 feet at the east. The rock here has a dip of  $70^{\circ}$  west-north-west, and it is traversed by two systems of joints, of which one crosses the quarry, dipping  $80^{\circ}$  north, and the other rolls to the south-east, with an average dip of  $30^{\circ}$ . The stone is coarse-crystalline and pure white. On the east side of the quarry the mill, engine-house and five derricks are placed. Two lime kilns at the south end, burn the spalls and the stone not used for building, into lime. The ridge of mica schist at the west has its beds in conformity with the beds of crystalline limestone, at the west border of the quarry. The Tuckahoe quarries were first opened about 1820. And buildings

erected sixty years ago show the excellent quality of this marble. Although so much has been taken out, the belt of stone is by no means exhausted.\* And with a revival in the marble trade these quarries could meet a large demand. When worked in 1873 the Masterton quarry is reported to have produced 200,000 cubic feet of marble. Formerly the stone was carted direct by teams to tide-water on the Harlem river. Latterly shipments have been by rail. And all are convenient to railroad. Blocks 27 feet by  $4\frac{1}{2}$  feet by  $2\frac{1}{2}$  feet have been dressed and put in the U. S. Custom-house at New Orleans. The U. S. Post-office at Washington, the U. S. Treasury building in New York, the City Hall in Brooklyn, are public buildings constructed of Tuckahoe marble. Besides these there are in New York city the Mutual Life Insurance building, the Fourth National Bank, the Park Bank, Herald building, Manhattan Life Insurance building, Stewart mansion, Ninth National Bank building, Arnold block on Broadway. In Boston there are the Sears building, Vendome Hotel, Revere Bank, Montgomery building, and many others.

**THE BATES MARBLE QUARRY.**—This quarry is situated a half a mile south-east of the Scarsdale railroad station, and in the south end of a low ridge of limestone. It is about 120 yards long by 50 yards wide. The strata dip  $45^{\circ}$  N.  $20^{\circ}$  W. On the surface the outcrops of the white limestone or marble are weathered and the stone is friable. The quarry has not been worked in some years and is partially filled with water.

**THE SNOW-FLAKE MARBLE QUARRY.**—This quarry is one mile south-east of Pleasantville in Westchester county. It is known as the Snow-Flake Marble Company's quarry, of which A. L. Pritchard is the manager. The place has been opened as a quarry about thirty-five years. The opening has a length of about 500 feet from south-west to north-east. The extreme breadth does not exceed 400 feet. The covering of earth on the rock varies from a thin soil to 10 feet deep, but the *stripping* is thicker as the upper beds and some of the top rock is worthless. There is very little water, and that which accumulates is siphoned out into the adjoining Cornell quarry. Formerly the stone was cut by channelling machine, and worked up in the mill, which is located near the quarry. At the present time the

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\*These quarries are in the town of Eastchester and they are described in Mather's Report on the First District as "Eastchester Marble Quarry."—See *Mather's Report*, page 454.



practice is to blast down great masses of rock, which are broken up into suitable blocks for building stone, and which are sent into the market rough dressed. The mill has not been worked for the past two years. This marble is white and very coarse-crystalline ; hence its name. It is somewhat harder than the Vermont marble and does not compete with the latter for monumental work. It was used in the St. Patrick's Roman Catholic cathedral, Fifth avenue, and in the front of the Union Dime Savings Bank building, Sixth avenue and Thirty-second street, New York city ; also in the M. E. church in Sing Sing.

HASTINGS, WESTCHESTER COUNTY.—The marble quarry on the bank of the Hudson, south of the Hudson River Railroad station, has been idle for a long time. The stone is a dolomitic limestone, white, and rather fine-crystalline.

SING SING.—A large quarry in the crystalline limestone, east of the prison and on the State property, was formerly worked for marble. The workings extend for a quarter of a mile from north-east to south-west, but the stone now raised is burned into lime. The old (marble) quarry is higher and nearer the surface than the present quarry floor. And the stone which is now taken out is, apparently, more durable and stronger than much of the marble. Some of it has a yellow-white shade, but the mass is white. In texture it is fine-crystalline.

This old quarry is famous for the buildings which have been constructed of its stone. The State prison buildings here and the State Hall at Albany are examples.\*

AT SPARTA, south of Sing Sing, marble is quarried by a New York city firm. The opening is at the east side of the main road and is about 200 feet long, north and south, and varies from 60 feet to 90 feet in width. The extreme depth is 40 feet. The beds dip 55° east-south-east. The marble has a yellowish-white shade of color, and is fine-crystalline. The outcropping ledges at the side of the quarry show that the surface rock is friable and crumbles readily to a sandy mass. The stone at the bottom is solid and apparently more durable.

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\* It is interesting here to refer to a statement made by Mather in his Report on the First District, p. 455, in which he says that "many blocks of this rock were brought to Albany for the construction of the new State Hall, that were already crumbling ; but whether they were put in the structure, or rejected by the builders, as they ought to have been, I do not know." Probably not, as we know the structure !

The white limestone in the DOVER PLAINS-PATTERSON VALLEY, has been worked at several points near Dover Plains, South Dover and Patterson for marble. The first quarry was opened on the Ketcham farm on Dover Plains, and near the foot of the East Mountain. It has been idle many years. Another quarry is on lands of Horace D. Hufcutt, and on the eastern side of the valley. The stone is white to bluish-white and rather fine-crystalline, and dresses easily. A plainly marked set of joints traverses the rock, dipping  $75^{\circ}$  north. The quarry is small, and but little stone has been taken out of it of late years.

The quarry of Geo. W. Ketcham is on the east side of the road, two and a quarter miles from Dover Plains. The strata here have been opened for a length of 300 yards on a line with the strike, S.  $5^{\circ}$  to  $8^{\circ}$  W., and for an average breadth of 70 feet and a depth of 25 to 50 feet. The strata dip  $85^{\circ}$  to  $90^{\circ}$  S.  $82^{\circ}$  to  $85^{\circ}$  E. One vertical joint system runs east and west, dipping steeply south. A second system is nearly horizontal, dipping a few degrees westward. There are two varieties of stone in this quarry, white and blue; but these varieties are apparently intermixed without order, sometimes in the same bed. About thirty feet of the stone is above the natural drainage. This quarry was opened by Mr. Ketcham in 1840 and was in operation up to 1883, since which time it has been idle. It was worked extensively, and for a time the annual output amounted to 40,000 square feet of stone. The whole went into monumental work.

Near South Dover marble was formerly quarried on a large scale at the Preston and McMichael quarries. The Preston quarries are two miles north-east of South Dover railroad station. The western opening is about half way up on the western slope of a long, low ledge of white limestone. The strata dip  $60^{\circ}$  westward. The beds are thick. The stone is white, containing more or less scales of white mica, scattered through it and is rather coarse-crystalline. The weathered or exposed ledges of this ridge appear quite solid and not much disintegrated. In the quarry the top stone is soft and crumbly. The eastern opening is on the east side of the ridge; it is about 375 feet long and 100 feet wide. The quarry face is 30 feet high. The dip is westward. A very marked set of joints dips  $30^{\circ}$  eastward. The quarry has not been worked in years, and the marble mill has been used for a tobacco drying-house.

There is a marble quarry, one mile south-east of Pawling, on the Patterson road, which has been idle for many years.

At Towner's Four Corners, in Putnam county, marble is quarried for common walls and foundations.

The marble quarries in the town of Dover were worked vigorously about forty years ago : the product was grave-stones mainly. The quarries are shallow excavations, and unlike the deep, underground quarries in Vermont. And the stone from these upper beds is probably not as solid and compact as that from deeper workings would be, nor as free from seams. Old analyses show it to be a dolomitic stone. But what portions may be less magnesian or even pure limestone is not known. Generally the stone is fine-grained, and much of it from the surface crumbles down to a granular mass on long exposure. It is not as coarse-crystalline as the Westchester county marbles.

NEW LEBANON, COLUMBIA COUNTY.—The marble quarries in this town were opened about fifty years ago. But they have been abandoned for many years.

GOUVERNEUR, ST. LAWRENCE CO.—At Gouverneur there are two companies at work quarrying marble—the St. Lawrence Marble Company and the Whitney Marble Company. Their works and quarries are located south-west of the village, about one mile distant. The St. Lawrence Marble Company's quarry is on the east side of the Rome, Watertown and Ogdensburg railroad line. This quarry was opened in 1878. The quarry is 100 x 90 feet and 70 feet deep, and at the side there is an additional area of 90 x 50 feet, from which the earth has been removed, leaving the marble ready for quarrying. The beds have a dip of  $22^{\circ}$ , and west of north. At the top the stone is light gray, the bottom is dark blue (resembling, when dressed, some of the gray granites). Both varieties are coarse-crystalline. At the junction of the two there are some impurities, due to a foreign admixture of mica and brown tourmaline and, rarely, pyrite, but this impure stone is thrown out as waste. The stone is very solid but splits most readily in the lines of the bedding. It is readily dressed, and is said to cut more easily than the Sutherland Falls marble, but it is not as soft as that of Rutland, Vermont. The crystalline rock, where uncovered, shows deep glacial furrows and smooth and polished surfaces. The covering of earth varies from a few inches to twelve feet in thickness. The stone is cut out by channelling machines, and the quarry proper may be said to be a rectangular pit, whose sides are nearly vertical. Very little water is met with in the quarry. Steam power is used for raising the water.



No powder is used and the stone is all cut out by machinery. The equipment consists of one steam derrick, a steam pump, four Sullivan diamond channelling machines, and one Ingersoll gadding machine. The mill for working up the stone is new and complete in its plan and equipment. A track from the quarry runs along the south side of the mill, and the large blocks as quarried are carried on cars directly to the works. There are sixteen gangs of saws with automatic feed, one rubbing bed and one turning lathe, and hoisting derrick for loading cut stone on the cars at the mill. The water for the works is obtained from a bored well 450 feet deep. The great use of this marble is for monuments. A large amount is sold for rock-ashlar, mostly to the western markets. The price for rock-ashlar at the quarry averages 25 cents per foot. The waste inferior stone is sold for common foundation and wall work in the village.

The Whitney Marble Company's quarry lies to the east of the St. Lawrence quarry and on the other side of the railroad track. The new quarry of this company measures 65 x 50 feet and 28 feet in depth. The earth on top of the stone is scarcely more than the thickness of the soil. The beds of marble dip  $20^{\circ}$  north, but a few yards away the dip is  $25^{\circ}$  north  $30^{\circ}$  east, showing considerable variation from point to point. The upper stone in this quarry is light in color and the bottom blue. Of the latter there is a thickness of 12 feet. A little mica and some tourmaline are noticed in the stone in the south-east corner of the quarry. In general the stone resembles that of the St. Lawrence Company's quarry, and is rather coarse-crystalline. In the quarry work one derrick, one Sullivan diamond channelling machine and one gadding machine are used. The quarry water is used for the boilers to run the machines. There is a small opening a few yards north of the present quarry, where some stone has been obtained. The old quarry on this property is about 150 yards north-east of the present opening, and is near the mill. This old opening has the dimension of 80 feet x 30 feet and is 50 feet in depth. It is no longer worked. The percentage of mica in the stone at the bottom makes it unfit for cutting or polishing, and hence the place is abandoned. One derrick still stands at the old quarry. The mill of this company has four gangs of saws, one rubbing table, one turning lathe and one loading derrick. A switch connects the mill with the main line of the railroad track, one-eighth of a mile distant. The greater part of the product goes for monumental work, but a part is put on the market for building purposes.

The Gouverneur marble was employed at least fifty years ago for grave-stones, and in the Riverside cemetery, at Gouverneur, these old grave-stones, bearing dates from 1818 onward, can now be seen. As compared with the more recently introduced Vermont, white marble head-stones it is more durable; and there is not so luxuriant a growth of moss and lichen as on the Vermont stone, but in the case of the older Gouverneur stone some signs of decay and disintegration, particularly on the tops, are noticeable, and small pieces can be chipped off with the knife blade. The durability of the stone for building purposes has been tested in some of the older structures in Gouverneur. Of course, it must be remembered that in them inferior and surface stone was used.

Gouverneur marble may be seen in a number of business blocks in the village of Gouverneur; in the Presbyterian church at Canton; in the Flower Memorial church at Watertown; in the county clerk's office, Albion; in three church buildings at Carthage; in the Merrick block, Syracuse; and in the Belden houses, Bryant avenue, Chicago.

CANTON.—A gray-white marble quarry is opened in this town, four miles easterly from Canton village. The stone is said to resemble that of the Gouverneur quarries. The place has not been worked lately.

### **Verd-Antique Marble.**

THURMAN.—A verd-antique marble is found in the town of Thurman in Warren county. The locality is eight miles north-west of Thurman station and five miles from Glendale, on the Adirondack railroad. The place was worked by a Saratoga company (the Verd-Antique Marble Co.) for three years, when it was abandoned. Some stone was cut and dressed at the quarry and put on the market, but it was seamy, and the quarry was not deep enough to test thoroughly the formation. The stone is yellowish-green (as represented by Museum block) and not the rich, deep shade characteristic of the precious serpentine.

BOLTON.—Serpentine occurs in this town also, but it is not quarried.

PORT HENRY.—A beautiful, variegated, verd-antique marble has been opened near Port Henry, Essex county, but has not been developed. It occurs associated with the white, crystalline limestone. Fine specimen blocks are in the State Museum collection.

## II.—SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.

### *GROUP OF QUARTZYTE AND SANDSTONE.*

#### **Potsdam Sandstone.**

FORT ANN, WASHINGTON COUNTY.—Jenkins White's quarry. The Potsdam sandstone is quarried at the side of the canal in a low bluff about two miles north of Fort Ann, and in the town of Fort Ann, Washington county. The working has opened the rock for over 100 yards in length, and the quarry face is at least 20 feet high. The beds have a gentle eastward dip and are traversed by vertical joints. The stone is grayish-white in color, hard and so close-grained as to resemble a quartzite. The stone is used for building at Whitehall, and is shipped by canal.

WHITEHALL, WASHINGTON COUNTY.—There is a fine section of the Potsdam sandstone to be seen in the cliff east of this town. The edges of the strata form an almost vertical rise of 100 feet. The stone is quarried out for common masonry, as foundations, retaining walls, etc., and is a cheap and valuable building material for such purpose. It is hard and strong. Its use is limited to the town.

PORT HENRY, ESSEX COUNTY.—The Potsdam sandstone crops out at the side of the railroad, north of the railroad station, and in the hillside west of the town. These outcropping ledges have furnished stone for common walls and ordinary building purposes. The principal quarrying operations are on the hill, west of the town, and a quarter of a mile west of the Delaware and Hudson railroad line, and within half a mile of dock on the lake. This quarry is owned and worked by L. W. Bond. The opening is about 100 yards long, on the upper side of the wagon road which ascends the hill in a southern direction. Only about 8 feet of beds have been worked. The dip of the strata is  $15^{\circ}$  easterly, and the beds are from one inch to 15 inches thick. The rock is divided vertically by joints which are irregular in their course, but have smooth faces generally. Near the surface the stone is weathered to a brownish color. There is no covering of earth on the stone. The quarrying operations consist in wedging off the beds without the use of blasting material. The stone are broken readily into convenient sizes, and the blocks are carted to the town, which is the principal market for this quarry. It is used for retaining walls, foundation walls, and for sidewalks. It sells at 50 cents per rod at the quarry, and at 75 cents delivered on cars



or boat in the town. A few men are employed for a part of the year, and the product of this quarry is comparatively small.

**KEESEVILLE.**—The Potsdam sandstone which crops out at Keeseville and at Au Sable Chasm, in both Essex and Clinton counties, affords a large amount of good building material for local construction. It has been extensively used in these villages both in the public structures and in numerous private houses and stores, etc.

On the Port Kent road, at the eastern end of the village of Keeseville, the Prescott quarry is worked at intervals, according to the demand for building material and for flagging stone. The quarrying is simply the removal of the surface, outcropping strata; and in this way a large area has been worked over. The beds are thin, varying from two inches to one foot. They dip from  $8^{\circ}$  to  $10^{\circ}$  in an east-south-east direction. The stone has a grayish-white color, with some yellowish and darker gray bands. Across the road from this quarry the same formation is opened and worked quite down to the bank of the river. The beds are thin and dip eastward. The material obtained here is mostly for flagging purposes.

On the right bank of the river, at the end of the village, and in Essex county, Richard Hoag quarries sandstone. The strata dip easterly about  $10^{\circ}$ . The main joints run vertically south. The beds are from three to 18 inches thick. The stone is grayish-white in color, fine-grained and hard, and the face of the quarry is nearly 20 feet in height. This quarry is worked at intervals, according to the demand.

**MALONE, FRANKLIN COUNTY.**—Quarries have been long worked in and near Malone, in the valley of the Salmon river, for the local market. Sydney A. Paddock, Antone Morris and Peter Bajin have quarries here. The stone is gray-drab with some of a reddish yellow color. It is hard. The beds are usually thin and even. Natural face blocks are used whenever they can be had. And in the town all the foundation walls, the retaining walls, bridges, sidewalk stone and several buildings are of this sandstone. Its durability is attested by its good state of preservation in these structures.

**POTSDAM, ST. LAWRENCE COUNTY.**—The formation in which the quarries of sandstone above described are found derives its name from this locality. The Raquette river in its northward passage has cut through and exposed the strata of sandstone for several miles. Four quarries have been opened along the stream at an average distance of three miles south-south-east of Potsdam.

The most southern quarry is owned by Mrs. Charles Cox. It was formerly worked by the Potsdam Sandstone Company. It is on the left bank of the river and close to the water. The covering of drift earth and sandstone strata is 20 to 30 feet thick at the west, and the same thickness was observed in the strata uncovered to the eastward. On the north the covering is only five feet thick. A striking feature of this quarry is the change in the direction of the strike, due apparently to a fault. At the west side the beds dip  $35^{\circ}$  to  $38^{\circ}$  S.  $25^{\circ}$  W., and the same dip and direction appear on the east side, but in the middle section of the quarry, having a breadth of 20 yards, approximately, the dip is  $38^{\circ}$  S.  $65^{\circ}$  W. The opening is not more than 90 yards long from north to south, and 50 yards wide at the north. The deeper part of the quarry has now 30 to 40 feet of water in it. The stone on the north side is thin-bedded, and these thin beds are worked for flagging and for crosswalk stone. The joints or "cut-offs" are vertical, or nearly so, and run generally in an easterly and westerly direction. A second system of joints runs nearly vertically, north and south, and these joints are generally close enough together to give convenient size to the blocks. Some of the strata show oblique lamination, but in general the layers are parallel with the bedding planes. The lamination is prominent in the stone because of diverse coloring, being red, gray and black, and hence some of the dark-lined stone is here locally termed "black stone." Very little work is done at this quarry and that is in getting flagging and crosswalk stone, and the stone is sold to dealers. The beds are wedged off by bars and split by sledging and hammer-dressed to sizes wanted.

The quarry of Thomas S. Clarkson is about a fourth of a mile down stream on the left bank. The covering here is 50 feet thick, and consists of a glacial drift; and the upper surface of the stone is glaciated. The beds dip at an angle of  $10^{\circ}$  to the south-west. The main joints run vertically in a south-westerly course. The face of this quarry opens to the south, and is about 100 yards long from east to west. Blocks of a very large size can here be obtained, as large as can be conveniently removed from the quarry. The drainage is natural, and no machinery is employed. The great thickness of the covering on the quarry stone makes the working of this quarry expensive, and it is no longer worked vigorously as in former years. The stone is fine-grained, compact and hard, and mostly of a salmon color. The dark-lined or "black stone" is harder to dress than the lighter colored varieties.

**THE POTSDAM RED SANDSTONE COMPANY QUARRY.**—This quarry is on the east side or the right bank of the Raquette river, about one-eighth of a mile above Clarkson's, and at a point where there is a bend in the river. The earth covering on the stone at this quarry is of an average thickness of 10 feet—in places amounting to as much as 15 feet. The length of the quarry face is not more than 100 yards from north-north-west to south-south-east, and the total thickness of the quarry beds averages 25 feet. The dip is  $22^{\circ}$  N.,  $80^{\circ}$  to  $85^{\circ}$  W. One system of joints, or "cut-offs," runs north and south, and dips easterly; another system courses north-west and dips  $65^{\circ}$  in a south-westerly direction. The first of these "cut-offs" is close, or what is known as a "tight joint." They assist greatly in the work of quarrying the stone. The beds in this quarry vary in thickness from four inches up to a maximum of six feet. Slabs four inches and upwards can be split off from these beds. The lamination is not as plain or as marked as it is in Clarkson's quarry, and hence the stone has a more homogeneous texture and appearance. It is lighter in shade, and nearly salmon color, varying to a faint pink shade, which is pleasing to the eye. It splits readily in planes parallel to the beds. It is hard; hence difficult to dress, and its hardness is shown by the frequent necessity of sharpening the drills used in cutting up the stone. Very little powder and dynamite are used in breaking up the larger blocks. There are two derricks and four steam drills. On an average, forty men are employed in this quarry, and the working season continues until freezing weather. In winter the work of cutting and dressing the stone is carried on in the sheds, which are on the river bank at the quarry.

About a quarter of a mile north of this quarry, and on the same side of the river, stone was formerly obtained for local uses, but this locality is no longer worked.

All of the stone from these Potsdam quarries has to be hauled by teams to Potsdam for shipment. On account of its hardness and the increased expense of dressing, and its liability to split on the lines of lamination, parallel to the beds, it is not so well adapted for fine cutting, but it is easily wrought and handsome for rock-ashlar. And for dwellings, its use is increasing rapidly.

The Potsdam sandstone can be seen in the Florence Flats, Syracuse; All Saints' Cathedral, Albany; the Reid buildings, Seventh avenue and Sterling street, Brooklyn; and in the Columbia College buildings, New York city. In the town of Potsdam the Normal



School buildings are of this stone ; also the Presbyterian church, the Universalist church, the Protestant Episcopal church, the Town Hall, and a number of store and dwelling-houses. Its durability has been tested in some of the old houses in the place, which are fifty to sixty years of age, and in which the stone is still sharp-edged, without a sign of scale or disintegration. The stone in the sidewalks in the town is from these quarries ; and it is admirable for flagging material, inasmuch as it does not wear smooth and become slippery, and dries quickly after being wet with rain.

In order to facilitate the working of these quarries and increase their output, a railway from Potsdam to the quarries is projected.

HAMMOND, ST. LAWRENCE COUNTY.—In the town of Hammond there are three sandstone quarries, which are now in operation : W. H. Stanley's, a half a mile south of Rossie station ; D. E. Parmeter's, one and a half miles north of the same station ; and H. A. Foster's, two and a half miles north of it. The Finnegan quarry, a half a mile north of Parmeter's quarry, is idle.

H. A. Foster's quarry is about 300 yards east of the Rome, Watertown & Ogdensburg railroad and on the west of the Black creek, and at the top of a bold ledge, 30 to 40 feet high, which bounds the Black creek ravine on the west side. The quarry consists of this cleared ledge for a length of 200 yards from north to south, running back in extreme breadth about 50 feet. The greatest depth is only about 10 feet. A wide joint system runs parallel to the ledge front, *i. e.*, north and south. These joints or seams are quite open, from one to two feet in places, and five to ten feet apart. Another system of joints, vertical, runs in a north-westerly course, but the north and south system dips steeply to the east, in places. The dip of the sandstone strata is less than  $5^{\circ}$ , and in an easterly direction. The upper surface rock of the quarry is glaciated and grooved. The beds are generally thin. The stone is grayish-white and hard, but dresses readily and breaks *true*, so that it is adapted for making paving blocks. The main product of this quarry is for street work, either as heavy flagging-stone or paving blocks. There are no derricks and no machinery in use. Very little powder is needed to break up waste rock. A side track runs from the quarry to the main railroad line. The drainage is natural, and the waste is shovelled directly over the ledge into the Black creek ravine. Hence the locality is worked to

advantage, and the length of the outcrop shows a great stock of stone. The lower beds, *i. e.*, below the present quarry bottom to the foot of the ledge have not as yet been opened or tested. They are exposed in the face of the bluff. This quarry was opened in June, 1887.

The Finnegan quarry is on the west side of the Rome, Watertown & Ogdensburgh railroad, and about half way between Rossie station and Foster's quarry. The quarry is in the eastern face of the ledge for a distance of 200 or 300 yards, and on the side of the track. The beds are thin and horizontal. One main system of joints runs east and west. The second runs N. 20° W. Much of the stone at this place is striped in color, red and white. It was worked for paving blocks and flagging-stone. It has been idle for five years.

The quarry of D. E. Parmeter also occupies the eastern face of the ledge or bluff, and is on the west side of the railroad. Its workings extend along the line of the railroad nearly 1,000 feet, from north-east to south-west. The floor, or bottom of the quarry, is about on a level with a platform car on the side track, making, as it were, a convenient natural dock. The stone at the bottom is hard and solid, and suitable for building, but it is not used. The quarry beds furnish a sufficient quantity for paving blocks, which is the great business of this quarry also. Their total (or the maximum) thickness, as seen at the north-west end of the opening, is 25 feet. The dip does not exceed 5°, and is east-south-east. The most plain and regular joint system runs north-east and south-west, and vertically, but not uniformly so. Some of them dip steeply. An open system of joints, less regular and less frequent, runs north and south. These joints facilitate the quarrying. The maximum thickness of the soil on top of this quarry is less than three feet. The beds of stone are from a few inches to three feet thick, but the thickest can be split up into thin flagging-stone. Generally they do not run in uniform thickness, but wedge out, as it were, forming basins, showing much irregularity in the original deposition. At the south end of the quarry the stone is striped, red and white, resembling some of the stone at the Finnegan quarry. It is broken up for paving blocks. The best stone of the quarry is white, or grayish-white in color, and fine grained. It is hard, but is readily split into convenient sizes for paving blocks. No blasting is done here. The beds are lifted by means of bars, and are split crosswise by drilling line holes and sledging, or by plug and feather wedges. The drainage is natural. There is

one derrick at the north-west end of the quarry. The output is mainly paving blocks. Some curb-stone, gutter-stone and crosswalk stone are taken out. As there is little local demand for building stone the lower, heavy beds, which are adapted for building, are not worked. This stone is not considered quite as hard as that of the Potsdam quarries, but this difference may be due to the fact that in this quarry the upper beds only are worked, whereas at Potsdam the quarry beds are deep, covered by earth and thin-bedded rock. The Parmeter quarry was opened twelve years ago.

The quarry of W. H. Stanley is in the town of Hammond, and is situated on the east side of the Rome, Watertown & Ogdensburg railroad convenient to transportation. The dip of the strata at this quarry is a few degrees eastward. The product is mainly paving blocks and some flagging-stone. The location is very similar to that of the Parmeter quarry.

The Hammond quarries are at present worked almost exclusively for street paving material. The product is shipped to western cities. The lower and heavier beds, which are adapted to building stone, are left unopened on account of the want of a local market and the more profitable business in making blocks. A large force of men is employed, and the aggregate output is large. The geological formation is Potsdam sandstone.

**CLAYTON, JEFFERSON COUNTY.**—The Potsdam sandstone crops out in the village of Clayton, and is generally covered by a thin layer of earth. The stone, which is got out in excavating for foundations, is used in building. It is gray, fine-grained and quite hard and suited for common wall work only. There is a small quarry near the dock on the water's edge, but it is worked in a small way.

### **[Sandstone of the Hudson River Group.**

**HIGHLAND, ULSTER COUNTY.**—The quarry of A. S. Clearwater is on the bank of the Hudson river, two miles north of Highland station, on the west side of the West Shore railroad track. The strata dip at an angle of  $20^{\circ}$  east-north-east, and the rock is very regularly bedded. The beds are thick, up to five to seven feet, and one is 11 feet thick. Well-marked, vertical joints divide the rock, running in a north-westerly and south-easterly direction, and a second system runs north-east and south-west. The stone is



blue, fine-grained sandstone. Occasionally small, slaty pebbles are seen in it. By taking advantage of the joints a single blast forces off great blocks, whose thickness is that of the bed, and which are then split up by the use of plug and feather wedges. At the top of the quarry there is a bed or tier 4 feet 9 inches thick, which is thus worked up into blocks one foot on a side and 4 feet 9 inches long. Near the bottom of the quarry there is an eleven-foot bed. The stone is hauled by teams under the West Shore track to the dock on the river or is loaded directly on the cars at the side of the track. It is shipped to New York city mainly, and for heavy work. The smaller stone are sold for dock filling.

**RHINEBECK, DUTCHESS COUNTY.**—The N. Y. C. & H. R. R. R. Company works a quarry a half mile south of Rhinebeck station, and in a bluff on the east side of the track. The bluff here has a height of 100 feet, approximately. The strata dip to the north-east at an angle of  $35^{\circ}$ , but there is a variation at the top, going southward, as well as to the north. Owing to this formation the best stone occupies the middle part of the face of the quarry as now opened. There are no well-marked joints traversing this rock. Some of the stone is black and shaly, and falls to pieces on exposure to the weather. The best, and that which is quarried for construction, occurs in beds from one to two and a half feet thick. It is of a grayish shade in color, and is a rather coarse-grained sandstone. On account of its hardness it is not readily dressed, and its principal use is by the company for the construction of bridges, culverts and roadway walls.

**NEW BALTIMORE, GREENE COUNTY.**—Four quarries are opened in the sandstone of the Hudson River slate formation at and near New Baltimore, on the Hudson, in Greene county. Beginning at the north, Smith & McCabe's quarry is in the river bluff at the north end of the village. The beds thus exposed for a length of about 100 yards along the river dip steeply eastward. The stone is dark-gray to slate-colored and fine-grained. This quarry is worked at irregular intervals of time, according as there is a demand for stone.

South of the village there are openings for a mile down the river, and all are somewhat alike in their exposure, kind of stone and in shipping dock accommodations. The stone may be described as a blue, slate-colored, fine-grained sandstone. The beds of sandstone are associated with interbedded, thin layers of shale, and are wea-

thered to a drab-colored rock on their outcropping edges. The waste, consisting of some top-dirt and the shaly strata, is thrown into the river on the front, making room for dockage; and the stone is shipped by boat to its destination. The principal use of this stone has been for dock-filling and for dykes on the upper part of the Hudson river. About twenty men are employed in the aggregate by these quarries. Formerly the business was much larger and many men were employed.

The first quarry south of the village is owned by A. V. S. Vanderpool. It is less than a half a mile south of it. The quarry face runs from north-north-east to south-south-west for 100 yards, and is worked back a distance of 25 yards. The present quarry work is in the line of strike, south  $30^{\circ}$  west. The beds are vertical, excepting at the top, where they are bent over to the east, an inclination apparently the result of glacial forces. A prominent joint system has its plane dipping  $30^{\circ}$  to the north-east. The quarry face has an extreme height of 100 feet at the south-west, and is 50 feet high at the north. The earth covering on the top is thin. The workable beds are dark drab-colored to blue, and are from six inches to eight feet thick. They are interstratified with a fissile, black slate, which varies in its layers from two inches to six inches in thickness. There are two thick beds of stone—one of eight feet, near the middle and the other three feet thick, at the back, or west. At the south-east corner of the quarry the beds have been disturbed by folding; and there the stone is harder than elsewhere in the quarry. The joint planes of division help in the quarrying, and the stone is rather readily broken into rectangular blocks of convenient size and shape. The quarry has a dock at river front, at which large vessels can load. It has been opened about 30 years.

Another opening on the same property is nearly 100 yards south of this one. It is not now in operation as a quarry. The beds in it dip  $70^{\circ}$  to the west-north-west.

Andrew Matthews' quarry is nearly one mile south of the village. Its dimensions are, approximately, 80 yards in length and 30 yards in width, and having a height of 50 feet at the back. The strata stand vertically. A remarkable fault (here termed a *slip-foot*) is seen at the west side. Its plane dips  $30^{\circ}$  eastward, and on the top section, looking southward, the strata are folded closely, with upper part of the synclinal cut off; on the bottom and below the faulting plane the beds dip eastward at an angle of  $30^{\circ}$ , conformably to the plane. The

sandstone is fine-grained, of a bluish shade of color, and is in thick beds. Some beds of slaty rock occur with the sandstone. The stone splits readily along planes in bedding and where there are thin laminae of calcite and quartz, known as "hair seams" and "salt seams." There is a dock on front at which boats are loaded. The quarry furnished stone for foundation of the Reformed church at Castleton. Formerly a great market was at Albany. It has been opened 23 years. To the south a few rods there is an abandoned quarry also owned by Matthews.

James Bronk's quarry, worked by Fuller & Sons, adjoins the abandoned Matthews' quarry. A large area at the north is no longer worked. The present quarrying operations are confined to a length of 200 feet. The strata here dip toward the north-east and at an average inclination of 30°. The beds are thick. One near the top measures 10 feet. And there is relatively less of the shaly or slaty rock here than in the other quarries of this group. There is a dock on the river where boats are loaded.

The New Baltimore quarries have no machinery for hoisting or drilling. Common black powder is in use for blasting. The stone are carted to the boats. And the whole product is sold for common walls or for dykes. The prices range from 30 cents per cubic yard on the dock to 75 cents and one dollar per yard, delivered on dykes in river, or for better grade of building stone.

**TROY, RENSSELAER COUNTY.**—Sandstone of the Hudson river group is quarried in this city for foundation work exclusively, and for the home market. Sampson's quarry on Pawling avenue, near the Memorial church, leased by William McLaughlin, is worked by a small force of men a part of the year.

Haverman's quarry on Fourth street, south of the Poestenkill, is run by the owner, and from eight to twenty men are employed. The sandstone is interbedded with slaty rock in these quarries, and there is some waste in the working. The stone is not adapted to fine dressing or cut work.

**AT AQUEDUCT, SCHENECTADY COUNTY,** there are three quarries. The largest one of these quarries is that of Levi Smith, on the south bank of the Erie canal and a half a mile west of Aqueduct station. It has a length from north-east to south-west of 800 feet. The order of succession of the strata from the surface is :



|   |              |
|---|--------------|
| 1. Earth.....   | 1 to 2 feet. |
| 2. Thin, slaty layers alternating with beds of<br>sandstone ..... | 10 feet.     |
| 3. Blue sandstone .....   | 10 feet.     |
| 4. Slate (as pierced in well hole).....                           | 3 feet.      |

In the upper ten feet there are three beds of sandstone,  $2\frac{1}{2}$  feet, 2 feet and 1 foot thick, respectively. The dip of the strata is less than  $2^\circ$  and is to the south-east. There are two well-marked systems of joints; one runs south  $32^\circ$  west, and dips  $88^\circ$  to north-west; the other runs south  $59^\circ$  east and dips  $85^\circ$  to  $88^\circ$  to south-west. These joints divide the rock into rectangular and step-like masses, and are at convenient distances for working. The stone splits readily and true, and is easily wrought into blocks for common wall work. Very little powder is used, as the masses are broken off by bars and split by sledging. There are no "sap faces" on the stone, and very little calcite or pyrite. The stone is fine-grained. It is in the horizon of the Hudson River slate and sandstone. And the bottom rock is black slate, containing scattering sandstone pebbles and mud cracks. No fossil organisms are found in any of the quarry beds. The drainage is natural, nearly to the floor of the quarry; a Worthington pump raises the water from the bottom to the level of the outflow to the canal. A rock breaker at the side of the railroad track uses the spalls and waste for road and street material. The stone is carted in wagons to the railroad side track (within a quarter of a mile of the quarry), or is loaded on canal boats at the side of the quarry. Albany, Cohoes, and Troy are the chief markets. The stone is known in the market as "Schenectady blue stone." The working season continues from March to December. This quarry was opened in 1862.

Levi Benedict's quarry is north of Aqueduct station an eighth of a mile, and has the canal on its west side. The opening is about 60 yards long and 30 feet deep. The strata dip southward at an angle of less than  $5^\circ$ . One main joint has a course of south  $42^\circ$  west. Another of south  $55^\circ$  west; and their planes dip  $85^\circ$  to north-west. There is a third system whose direction is in general south-east, and whose plane dips  $85^\circ$  to south-west, but it is not so well defined as the others. The vertical succession of the strata is:

|                                  |          |
|----------------------------------|----------|
| 1. Slate, brownish colored.....  | 10 feet. |
| 2. Slate and blue sandstone..... | 9 feet.  |
| 3. Blue sandstone.....           | 2 feet.  |

The slaty rock is waste. The quarry is worked at irregular times.

About 20 rods north of the above mentioned quarry there is another opening in the side of the bluff, and higher above the canal. And in it the dip of the beds is as much as  $7^{\circ}$ , and southward.

Across the river, and on the Saratoga county side, sandstone has been quarried at Rexford Flats by C. W. Rexford.

SCHENECTADY.—The quarry of Shears & Dunsbach is one mile easterly from the railroad station, but within the city limits. It is 100 yards south of the railroad and the Erie canal. Its extent from north-east to south-west is at least 200 yards, and 100 yards from north to south. The drainage is natural and northward to the canal. The stone is covered by a true glacial drift, which has in it large imbedded masses of stone and boulders of all sizes. This boulder earth is so hard and firm in places as to require blasting to break it down. The glacial forces appear to have removed all the rotten or disintegrated stone and slaty beds, and to have covered and protected the solid rock mass. Hence the top stone is good for quarrying. Unlike the Aqueduct quarries, there is no slaty rock at the top or interbedded with the sandstone. The drift earth is from four to ten feet thick. The quarry beds are from one to three feet thick, and the total thickness is from 10 to 15 feet. The dip is less than  $5^{\circ}$ , and in a south-west direction. The main system of joints runs south  $50^{\circ}$  west. A second system has its course south  $15^{\circ}$  west. A third system runs at right angles to the first one, but is not well marked. They are vertical or dip steeply to the north-west. The stone is of a bluish shade of color and is fine-grained. As the joints are at convenient intervals for working and the stone is readily broken in planes at right angles to beds and joints, blocks of rectangular shape and of good size are obtained without the use of much powder. And the natural faces save dressing for much wall work. No machinery is in use. The stone is carted to railroad or canal, 100 yards away, or is taken to the building sites in the city directly, by teams. It is used in Troy, Cohoes, Waterford and Albany, as well as largely at home, and is known in the market as "Schenectady blue stone." A large amount goes into foundations. It can be seen as rock-ashlar in the East Avenue Presbyterian church in the city and in the Memorial Hall of Union College. The quarry was opened about 15 years ago, but little was done in it until nine years ago. The extent of stone and its solid character make the quarry valuable, and a source for supply to the adjacent country.

The shaly nature of much of the Hudson River group of rocks in the Mohawk valley, west of Schenectady, and the accessibility of good limestone for building purposes, has prevented the opening of quarries in it. Further west, and near Rome, there are small quarries which are referred to this horizon, but they are unimportant. The sandstone quarries in the towns of Camden, Oneida county, and of Orwell in Oswego county, belong in it. The stone is generally gray in color, fine-grained and hard and in moderately thick beds. None of these quarries do much more than a small local business; and they are not in operation all the working season of the year.

### **Medina Sandstone.**

**OSWEGO.**—Quarries have been opened in this city from the Fort Ontario grounds eastward to the N. Y., O. & Western R. R. Co.'s shops on the lake shore. They are small, and are worked by a few men, at irregular times, for stone to be used in the construction of foundation and retaining walls. The covering of earth is shallow—on average three feet thick—then a shaly rock in thin beds, and under it the quarry beds from five to eight feet thick. The stone is light gray in color and rather coarse-grained, but it is strong and hard and suitable for inside walls, foundations, etc. A large quantity has been put into buildings in the city. In the United States grounds there is a large quarry. It has been idle for many years. The formation belongs to the Medina epoch.

**OSWEGO FALLS, OSWEGO COUNTY.**—The Medina sandstone formation, as exposed along the Oswego river, is worked for building stone at several points near the village of Oswego Falls. One of the quarries is on the lands of a mill company and near the falls and on the left bank of the stream. It has been idle for years.

About a quarter of a mile north-west, on the left bank of the stream, Hughes Brothers, of Syracuse, have a quarry—James Faulkner and Michael Nealis are the lessees. It was opened 16 years ago. The succession of strata is as follows: First, sandy loam, 3 feet 2 inches; red, sandy earth and shaly rock, 11 feet; red sandstone beds, 19 feet; clay and rotten rock, 3 inches; red sandstone, 14 feet. A well sunk for the removal of water showed 10 feet of sandstone below the quarry bottom. The old quarry pit, north-west of the present face, or working, is now filled with water to a depth of 16 feet, and no beds below the water level are worked. The beds dip very slightly to the west. So far as observed, one vertical joint only



appears. Its course is north-west. Generally the beds of sandstone are separated by thin layers of shaly rock. The top stone is somewhat inferior, on account of its shaly pebbles, which on exposure crumble and fall out. The more solid beds, near the main water level of the stream, make good stone for dressing and cut work. The inferior stone is sold for common walls and foundations. The cut and dressed material is used chiefly for house trimmings or rock-face ashlar. The market for the greater part of the product is Syracuse. There is one derrick; and the stone are loaded directly on boats at the side of the canal. The stone in this quarry is dark red in color, rather soft, and dresses easily. At the bottom it is harder and more homogeneous in texture. Some of the upper strata have a *reedy* structure.

A large amount of stone has been taken from the strata on the river banks at Oswego Falls, and used in Fulton, and in Oswego and Syracuse. Owing to a lack of care in selection much inferior stone has gone into the market, and it has greatly injured the reputation of the Oswego Falls stone. The First Presbyterian church in Syracuse, corner of South Salina and Fayette streets, is an example of this stone, badly selected, and to a large extent with the blocks set on edge. And withal this stone has a rich, deep and pleasing tint; and its weathered blocks give the edifice an appearance of age.

GRANBY BROWNSTONE COMPANY'S QUARRY.—This quarry is in the town of Granby, two miles from Fulton and at the side of the Delaware, Lackawana & Western railroad. The first opening was made in the spring of 1886, and the present quarry consists of a square pit, 85 feet on the side and 60 feet deep. The work here has been done by the use of a channelling machine. The quarry is in a little depression, and the earth covering on the rock was scarcely a foot thick. For three feet down the rock is shaly and somewhat broken up. And down at least 16 feet the stone is traversed by irregularly running seams; and there are shaly pebbles in the sandstone; and some parts of the stone have a grayish-green color, as if the stone were not so thoroughly oxidized in them as in the main mass. These shaly portions disintegrate on exposure, fall out and disfigure the stone. The bottom rock is quite free from them and from seams also. It is fine-grained, of a purple red shade of color, and admits of fine tool dressing, and is adapted to highly ornamental work. In the quarrying work there are in use: one Ingersoll channelling machine; one Ingersoll drill; two steam derricks and a steam pump. The

boiler-house stands close to the quarry. A side track about 200 yards in length connects the quarry with the main line of railroad. Very little trouble is experienced from water, and a brook near by supplies the necessary water for the boiler. By means of a channeling machine the sides of the quarry are cut down, and the blocks are split apart by plug and feather wedges. The blocks cut apart in this way are lifted by wedging them off the bed. Blocks as large as can be conveniently handled, can be obtained. The stone is suited to fine dressed, ornamental work or for heavy masonry, but care is needed to select stone free from seams and from shale pebbles. The Granby stone is being used in the building of the Second National Bank of Oswego, now in course of erection. And it has been put into the Protestant Episcopal church edifice and ten store buildings in Cortland.

CAMDEN, ONEIDA COUNTY.—A sandstone, presumably in the Medina formation, is quarried in this town, for local use. It is light gray in color, and coarse-grained. The greater part of the stone is used for flagging. Some of it is shipped to Oswego.

The Medina sandstone formation has yielded some building stone in the town of Sterling in Cayuga county, and in Wolcott in Wayne county, but the quarries there opened have been worked for local use only and to a small extent. A little stone has been taken out in Penfield, Monroe county, but the Genesee river marks the eastward limit of the more extensive quarry district in this formation.

Medina sandstone, in its more restricted sense, is quarried near the line of the Erie canal, from Brockport, in Monroe county, west to Lockport, in Niagara county. At Rochester the Genesee gorge exposes to view the sandstone, and formerly some stone was quarried in the city.\* Of late years it has been neglected, and the stone from the quarries further west has been used in its place.

BROCKPORT.—Two quarries are opened at this place. They are owned by Geo. Coon and Hugh Quinn.

HOLLEY, ORLEANS COUNTY.—There are three quarries in operation near Holley station on the N. Y. Central railroad. The quarry of Gorman & Slack is nearest to the station, and on the south side of the Erie canal. It is opened in a level country and adjoins the canal.

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\* See Hall's Report on Fourth District, pp. 432-3.

The *stripping* of drift earth and some imbedded angular masses of sandstone is thin. The stone of this quarry has a light red color, and is fine-grained. It is worked into paving blocks\* and into building material. A side track at the quarry affords convenient facilities for loading directly from the quarry.

The quarry of Timothy O'Brien is three-quarters of a mile east of the Holley station, and on the south side of the railroad track, and also of the Erie canal. It was opened in 1881. About three acres has here been worked over. The *stripping* consists of drift earth, largely made up of fragments and masses of broken sandstone. The beds of stone here, as in the Gorman & Slack quarry, are horizontal. A marked feature is a system of joints, which runs east and west, and dips steeply north, and 15 to 20 feet apart. A second system, not so commonly observed, runs south, and in a more irregular course and dip. The total thickness of the rock quarried ranges from 7 to 15 feet, and the bottom rock is a coarse-granular, dark-brown sandstone, which is very hard and breaks hackly. Underneath this bottom rock is a red sandstone bed known as "red horse." The quarry water has to be raised four feet to the level of the out-flowing ditches which carry it off north to the canal. The product is mainly paving blocks, with some stone for building purposes. The stone is sold in the rough for crosswalks, curbing and general building work. Much of it goes to Rochester; some to Buffalo. A large force of men is here employed for about seven months in the year, or until the beginning of freezing weather.

One mile south of Holley an old quarry, known as the "cider mill quarry," has been reopened the past season by Hiram Joslyn, of Holley.

**HULBERTON, ORLEANS COUNTY.**—The Hulberton group of quarries are located on the north side of, and close to the Erie canal. Beginning at the east, the first opening is that of Sturaker & Sullivan. This quarry was first opened in 1884. The *stripping* on the stone consists of earth and broken stone, a few feet thick. The workable beds together are 10 feet thick, and at the bottom is a dark, brownish-red, coarse-granular sandstone. The quarry runs about 250 feet in length, parallel to the canal. One system of joints runs east and west, vertically. The others run in an irregular course. Some of the beds are obliquely laminated, and at the bottom, on the east side,

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\*The paving blocks made in these quarries are, in part, sold with the product of the Albion quarries, and are known as Medina paving blocks.



there is a sloping floor, dipping 18 to 20° south-west, against which the red sandstone of the quarry beds abut. The output of this quarry is largely paving blocks, which are carted to the canal and shipped by boat. The stone of the beds which are worked, is red, and fine-grained.

The next quarry, going west, is that of Thos. Lardner. This is also close to the canal, and measures about 200 feet on a side. At the top the earth, boulders and imbedded masses of sandstone form the *stripping*, which is six feet thick. The quarry beds aggregate in thickness 12 feet. A well some 14 feet below the bottom, is all in sandstone. The beds are thin, and the stone in some of them is coarse-grained. The general direction of the joints is east and west. Much of the stone is shipped to Rochester for rubble work and for cellar walls. It is sold there at as low a rate as Rochester limestone of the city quarries. A large part of the stone is worked into paving blocks, curbing and crosswalks. This quarry was opened in 1884.

Barnard O'Reilly's quarry is about 60 rods north-west of Lardner's and on the same side of the canal, and 20 rods, approximately, from it. Its dimensions are about 300 feet each way, and 25 to 30 feet in depth. The *stripping* consists of earth and broken stone to a depth of 10 feet. Some good stone is obtained from these loose masses in the top earth. The quarry beds are from 4 to 10 inches thick, and have a total thickness of 15 to 18 feet. The joints are very irregular, and some of them curved. They are also remarkable for being open and filled with dirt. These open or dirt-filled *seams* are of great service in the extraction of the stone. The stone is mostly red in color, fine-grained and breaks readily and *true*. One steam pump raises the quarry water. Two derricks are used in hoisting the stone. It is carted to the canal and shipped by boat. The product is mainly paving blocks and street material (curbing and crosswalks). The principal markets are Cleveland, Toledo and Indianapolis. This quarry was opened in 1882.

Alfred Squire's quarry is within 300 yards of the O'Reilly quarry north-west and on the same side of the canal. It is about 350 feet long and 200 feet wide. The *stripping* of earth and imbedded stone does not exceed 8 feet. Then come a few thin beds, which are used for street work, and for common blocks. Under them a thick-bedded sandstone is quarried. There are no regular joints or *seams*, but irregularly curved joints occur at distances convenient for getting

out the stone. The bottom floor of the quarry is a dark-brown, coarse-grained sandstone. Blocks of very large size can be obtained. In fact, the limit to the size is that of handling and transportation. All of the thick-bedded stone and the larger part of the product of this quarry is worked into building material, and is shipped in the rough. A steam pump is in use for raising the water ; there are two derricks for hoisting the stone. It is carted to the canal and shipped by boat. This quarry was opened in 1865. The stone of the thick beds is fine-grained, of even texture and of a light-red color. Stone of the Squire's quarry can be seen in the Delaware Avenue M. E. church, in Buffalo ; in the Sibley Hall, Cornell University, Ithaca, and many other structures. Rochester and Buffalo are the principal markets.

Lafayette Cornwell's quarry is the next one to the north-west. It was opened in 1887. The quarry beds are from 2 to 12 inches thick ; and in all, there is a thickness of 7 feet of such quarry stone, underlying 5 feet of *stripping*. The stone is deep-red in color. It is suitable for building or street work. A small number of men are employed.

Going on, north-west there are the quarries of Constantine Van York, Charles Gwin, Barnard O'Reilly (leased to M. Scanlon) and Chadwick Brothers.

The Hulberton quarries are all embraced within a narrow belt on the north side of the Erie canal, two and a half miles in length, from north-west to south-east. They are all excavated below the level of the canal, and hence the pumping of water is necessitated in all of them. Their stone is shipped over the canal ; and in all about 120 men are employed in these quarries. The working season continues from spring until freezing weather, in the early winter. Much of the Hulberton block is sold by the Albion Stone Company, and goes under the name of Medina block.

ALBION, ORLEANS COUNTY.—The largest quarries in the Medina sandstone formation are at Albion. They are on the east of the town, and opened in a comparatively flat, farming country, between the Erie canal on the north and the New York Central railroad on the south. They are below the railroad grade and not much above the canal level. The most westerly opening is in the town, and is known as Sandford's quarry. A large area has been quarried over. It is now idle.

The GOODRICH & CLARK STONE COMPANY'S QUARRY is the next one, going eastward, and is about half way between the canal and the railroad. It was opened three years ago. The excavation is about 350 feet long, from east to west, and 300 feet wide. The *stripping* consists of sandy earth, from 3 to 10 feet thick, and imbedded in it there is some broken stone. This quarry has been worked to a depth of about 18 feet. The beds dip to the south at a very low angle. The joints run east and west generally or south  $85^{\circ}$  west, and are from 12 to 30 feet apart. A second system runs north and south, and dips steeply eastward. At the south side the beds are thin. On the north they are thicker, up to four feet. The stone is red in color, fine-grained, with some greenish-grey laminae on the bedding planes, or what may be termed sap edges. They are usually less than a quarter of an inch thick. Some of the beds show a striped, laminated structure. Some are marked by cross bedding, while others are entirely homogeneous in texture. The stone can be split readily in planes parallel to the bedding. The upper sides are generally smooth, true and faintly lined as if wind had drifted sand over the original surfaces. And these surfaces are good for platforms and flagging-stone. The water of the quarry passes into a sewer at the bottom of the quarry, and goes north under the canal. Some of the stone is sold for common rubble work. A part of the inferior or poorer grade is split into paving blocks; the best is used for building stone or paving blocks. The stone is carted to the canal and shipped by boat to destination.

ALBION STONE COMPANY'S QUARRY.--This property embraces the old Sickles quarry, and what is known as the Sullivan quarry. It was first opened thirty years ago. The present company has connected these quarries by its working; and the present excavation is now nearly 2,000 feet long, from east to west. At the west end the quarry has advanced quite to the railroad line. The total area worked over is approximately estimated at eight acres. The *stripping* at the west end consists of earth and thin, shaly rock, having a thickness of 10 feet. Eastward the shale disappears, and the earth alone averages 10 feet thick. It is of a red, sandy nature, and is readily removed. On the west this quarry approaches within a few rods the east line of the Goodrich & Clark Company's quarry, but it extends much further to the south. The beds vary in thickness, thinning out wedge-like, as others come in to replace them. So also the stone varies in character from point to point, even in the same



bed. The thickest bed is 6 feet. The general direction of the main system of joints or seams is east and west, and vertical. The others are irregular. In some cases they are filled with earth, and these dirt seams help greatly in the working of the quarry. The total thickness of the quarry beds at the south amounts to 30 feet. It is less on both the east and west sides. Some powder is used, but so far as possible the beds are lifted off by wedges, and split apart by plug and feather. The stone is carted to the cars at the side of the quarry, on the south, or to the canal on the north. The water at the bottom of the quarry is pumped to the level of the drain, which flows north into the canal. There are two derricks in the quarry for hoisting the stone. The beds here also have a smooth upper surface, and what are known as sand lines. Oblique lamination is seen in some of the beds, and where thus laminated, the stone is cut up into paving blocks. The best stone is sold for building purposes and platform flagging, but the greater part of the product goes for paving blocks; and principally to Cleveland, Columbus, Toledo, and other places in the west. For paving material two grades are made; one is known as the block pavement, and the other the common, natural face stone. A large number of men are employed at this quarry throughout the working season, and the annual output amounts to hundreds of car loads. The stone of this quarry is rather brighter red than that of the other Albion quarries, approaching the Hulberton stone in shade. It is fine-grained and even in texture. The Presbyterian church in Albion is a beautiful example in construction, of this company's stone.

GILBERT BRADY'S QUARRY is less than half a mile east of the last described, and one and a half miles from the Albion railroad station. It is similarly situated in reference to the canal and railroad. The face of the quarry has its greatest length from east to west, and the whole distance from the east end to the west end is 150 rods. The *stripping*, of red sand, varies from 10 to 15 feet thick, and the surface of the stone underneath this sand bed is glaciated and hard and solid, as if the upper and shaly strata had been removed therefrom by the glacier. The beds have a general dip of a few degrees to the south-east. A remarkable feature of this quarry is the uniformity in the direction, and in the spaces between the seams or joints. The direction of these seams is nearly east and west and vertical, and they are from 12 to 30 feet apart; and in nearly all cases filled with

earth. The north and south seams or joints are not as common and not so regular. The stone is brown in color, with thin, gray-green layers at the bed parting. On the faces of the seams it is often a rusty red. The color generally, is not so bright as that of the stone of the Albion Stone Company's quarry. The quality varies greatly in narrow belts from east to west. The best stone is found at the extreme front, on the south. On the west side of the quarry the beds are of a darker-brown shade and coarse-grained; and this stone breaks unevenly. It is split up into blocks. Unlike the other Albion quarries, the greater part of the output is building stone, and is the best material of the quarry. Only that which is not good for building purposes is split into blocks. The total thickness of the quarry beds is 14 feet. The upper surfaces of the beds here also are smooth, and marked by lines of wind-drifted sand, as are seen to-day on the strand at the seaside. The working of the quarry is largely determined and helped by the regular joints; and it moves southward, taking a section between these vertical seams at a time. As the northern end is free, the beds are readily wedged off and raised up. Very little powder is used. Steam drills are employed to put down holes, in line from joint to joint, for splitting apart. There are fourteen derricks, all of which are worked by hand, not counting the derricks at the canal dock, which are used for loading. A road follows the face of the quarry around from east to west, and the stone are loaded directly on wagons, and carted to canal or railroad. As the excavation moves south the area worked over is filled again with waste stone and earth, and is thus returned to farm land. This quarry has been worked more than thirty years by Mr. Brady. It is a model for neatness, convenient arrangement and economic management, as well as one of the best quarries for superior building stone. The stone are cut and dressed at the yard of Gilbert Brady & Company, in Rochester. Examples of this stone in construction are: the Guernsey building, Broadway; Marquand house, Madison avenue and Sixty-eight street, in New York city; Gen. McDougal's house in Auburn; and the steps of the new staircase, west side of capitol at Albany. In Rochester and Buffalo there are numerous structures in which it has been used.

The total output of the Albion sandstone quarries is estimated by Mr. Gilbert Brady to amount to 45,000 tons. About 400 men are employed during the season of quarrying, and the value of the stone for all uses is estimated at \$250,000.

**MEDINA, ORLEANS COUNTY.**—Near the town of Medina there are nine quarries, which are worked more or less all of the time during the quarrying season. They are north and north-east of the town and all are within a mile and a half of the railroad station. They have been in operation for many years, and the aggregate area worked over is large. The total number of men employed in these quarries, in the height of the season, amounts to 450, and the working period lasts from May to November. The stone at Medina differs from that of the Albion quarries in the gray-white color of much of it, and in the abundance of fossil shells and fucoid impressions in some of the layers. The stone generally is harder. The spotted, red and white, or variegated stone, also is a feature of the Medina quarries. Oblique lamination of the beds is more common than at Albion or Hulberton. Pyrite-coated seams or joint faces also are to be noted, as a mark of the formation which is seen in the older quarries especially. Formerly the gray or white stone was in fashion, and nearly all of the gray variety was sold for building. The present demand for building is for the red and variegated varieties, and all of the gray stone and much of the red stone are split into blocks for paving. And a comparatively small fraction of the total output is put into market for construction.

**KEARNEY & BARRETT.**—The quarry of Kearney & Barrett is on the north side of the Erie canal, in the north-west part of the village of Medina, and a half a mile from the New York Central railroad station. It was opened in 1840. A large area has here been worked over, close to the canal property, having a length, from east to west of 1,500 feet, and an estimated area of seven acres. The *stripping* consists of a red, sandy earth, in places quick-sand, with some imbedded masses of sandstone. The sandstone in this top material yields a sufficient amount of workable stone to pay for its removal. The thickness of the *stripping* varies from two to three feet at the west end and ten feet on the south side. The greatest thickness of the quarry beds, as here worked, amounts to 30 feet. In the middle of the quarry the shale, which is known as “red horse,” rises up in a north and south belt, running across the quarry, and very little good stone is obtained from that part of the quarry. The dip is very gentle southward. A main system of joints or seams runs east and west. The second system runs north-west and south-east, but not nearly so regular as the first. A third system courses north, but dips about 60° east. There is a noticeable variation in the bedding



from point to point, and the beds are seen to thin out while others form thick lenticular masses between these more narrow, wedge-shaped beds. Cross-bedding and oblique lamination are also common. The beds vary in thickness from a few inches to three and four feet. On the eastern side of the quarry there is at the bottom a heavy bed of what is known as variegated rock, and under it a thick bed of white sandstone. In this variegated rock the matrix is red, and in it are these white, spheroidal masses. In working, the color guides in the separation and selection of the stone, according as the demand calls for several kinds. The red stone is now most in favor. The variegated is also highly esteemed. Steam pumps are used for unwatering the quarry, but no steam drills are used. The stone is carted by team to the canal and railroad. The product is building stone for house trimmings, rock-ashlar, paving blocks; crosswalk and curb stone are also obtained. The chief markets are Columbus, Detroit, Kansas City, Cleveland, Rochester, Buffalo and Erie. The quarry is worked about seven months in the year, and at times as many as 100 men are employed.

**JAMES HOWELL.**—This quarry is east of the last described, and between the two roads leading north and west from the village. Its face, fronting east-north-east, has a length of nearly 1,000 feet, in somewhat of a zigzag course. The *stripping* is light, containing some broken stone with the top earth. Near the top there are shaly beds interstratified with the sandstone. These disappear down, and then the sandstone beds are heavier. The whole thickness of the quarry beds here worked, amounts to 18 feet. The product is almost wholly for street work. This quarry, like that of Kearney & Barrett's, is below the canal level, and the water accumulating in it has to be raised by power.

**JOHN A. HOLLOWAY.**—This quarry is on the right bank of the creek, and on the west side of the canal. The working face at present is towards the west, and has a length of 500 feet from north to south. A large area has here been worked over, and huge dumps lie disposed about the quarry. The *stripping*  $3\frac{1}{2}$  feet thick is shaly beds. The quarry beds have a total thickness of from 10 to 12 feet. The drainage is natural into the creek. The seams are somewhat irregular, and some of the beds are much disturbed and broken by them. In some cases the joint faces are coated with pyrite. The stone is mostly grayish-white, hard, and some of it shows oblique

lamination. The quarry is worked on contract, for paving stone, the men furnishing the tools and receiving so much per cord for stone quarried. The stone is carted to the canal, a few rods east of the quarry.

PATRICK HORAN.—North of Holloway's quarry is that of Patrick Horan, on the west side of the main road, and west of the canal also. The length of the working face, which fronts on the west, is about 800 feet, and a breadth of about 500 feet has been worked over. At the south end the drift earth covering the stone is 6 feet thick, and the quarry beds have a total thickness of 18 feet. At the west end there is 12 feet of earth, and then 12 feet of stone to the level of the water, and natural drainage. The older working was 10 to 12 feet deeper, making in all 22 feet to 24 feet of beds quarried. The beds are quite irregular, and vary from a few inches to 2 feet in thickness. There is some spotted, red and white (or variegated stone as here known) at the top, but the prevailing shade is gray, especially at the bottom. Some of the beds are obliquely laminated, and these work up badly. No machinery is employed, and this quarry is worked in a small way.

JOHN A. HOLLOWAY'S QUARRIES.—These quarries lie east of the road and east of the last described. There are two separate openings and about 40 yards apart. At the northern-most quarry the *stripping* is from 5 to 6 feet thick, below which there are from 10 to 12 feet of beds, which are workable, mostly a grayish-white stone. At the south the quarry covering is from 5 to 8 feet thick, and the quarry beds aggregate 12 to 18 feet. Nearly all of the stone is a gray-white in color, known in the market, however, as white stone. The product of these quarries goes into street work and building stone.

PATRICK HORAN.—Horan's main quarry is a quarter of a mile east of Holloway's, and one mile north-east of the Medina railroad station, and about sixty rods from the canal. Two and half acres have here been worked over, and the quarry has a length of 600 feet from north to south. The *stripping* is from 12 to 15 feet thick, and contains some imbedded masses of sandstone, which are worked up into building stone. The quarry beds have a total thickness of 10 to 12 feet, and range from a few inches to  $2\frac{1}{2}$  feet thick. The common feature here observed is the irregular or uneven strata, thinning out or wedging out between others and basin-shaped beds. At the bot-

tom there is a greenish-gray and mottled rock, which is so seamy and has so much iron oxide on it that it is worthless. The stone of the quarry beds is nearly all of a red or deep brown color, and fine-grained, but variations in texture and in shade of color from bed to bed and from point to point in the same bed, is observed here as in all of these Medina quarries. One main system of joints runs vertically east and west, but somewhat irregular in its course. A steam pump is used for raising the water. The stone is carted to the canal. The product of these quarries consists of building stone, which is sold in the rough generally, and is used for house trimmings and for rock-ashlar. The stone for street work is flagging and platforms, some of which are as much as 20 feet in length and having smooth natural faces. Stone for curbing, crosswalks and natural face blocks are also produced. A large force of men is employed, and the output of the quarry is large.

MCCORMICK.—A. J. McCormick's quarry is north-east of Horan's, and separate from it by a property line only. The south front, or face of the quarry, has an eastern and western course, and is on a line with Horan's north limit. On the east of this main quarry there is a second and smaller opening, also belonging to McCormick. It was opened in 1871. The eastern opening is worked at times, for paving stone principally. The main quarry has an estimated area of four to five acres. The *stripping* here is red, sandy earth, with scattering masses of sandstone imbedded in it, and is five feet thick. Under it is an inferior, shaly, thin-bedded, reddish sandstone, three feet thick, suitable for common wall stone only. Then come the quarry beds which are from 2 inches to 6 feet thick, together amounting to 15 or 18 feet. The thick beds can be riven into platforms, flagging stone, etc., if so wanted, or are sold for building. The dip of the beds, as at all of these Medina quarries, is south and at a very small angle, and hence as the quarry work moves south, successive beds appear at the top. The joints are regular; one system east and west, being vertical and one system north-east and south-west, but more irregular. The faces of these joints or seams are in part coated with pyrite. The stone is red, with a little of it variegated. No derricks are used. The water is raised by steam power. There is a quarry dock on the canal a quarter of a mile away. The product is largely for street work, such as curbstone, crosswalk-stone, flag-stone and paving blocks. Some stone for rock-faced ashlar, for buildings and for house trimmings, is sold, mostly in the rough. It is



shipped by rail and canal. The curbstone and crosswalk-stone are dressed at the quarry.

**NOBLE & LYLE QUARRY.**—This quarry is situated a quarter of a mile north of the canal and one and a half miles north-east of Medina, on lands of Hiram Reynolds. It has been in operation about twelve years. It is about 100 yards in diameter, being nearly circular in shape. The earth covering is from five to six feet thick; the quarry beds from one to three feet thick, and have a total thickness of 16 feet. They dip south at a small angle. The bedding of this quarry is very regular and even, and there is an entire absence of oblique lamination and basin-shaped beds. The rock at the bottom is seamy, and worthless on account of its shaly nature, and is known as "red horse." The stone is generally of a brown or reddish-brown color, more like the Hulberton than the Medina stone. It is rather softer than the stone of the other Medina quarries, and is easily dressed. Some of the beds on the east side are of a grayish-white color, and harder. The product is almost wholly put into building material. A very little is sold for curbing, flagging, crosswalks, and for paving block.

**LOCKPORT.**—On the north of Lockport the Medina sandstone formation has been opened at a number of points on an 80-acre tract owned by Chas. Whitmore. These quarries are on both sides of the road leading to Olcott, and on the right bank of Eighteen-mile creek.\* Work has been done on the hill north-east of this Olcott road in a small way, in many separate excavations, which are from three to five feet deep. The product, a gray sandstone, is split up into paving blocks. South-west of the road, and in the face of the bluff, and below the smelting works, the main quarries are located, which are now worked. The *stripping* is heavy, 18 to 20 feet thick, including red, shaly beds, with hard sandstone, most of which is thrown out as waste. The quarry beds dip gently south. The vertical joints run generally east and west, dividing the rock into convenient blocks for quarrying. Both red and mottled varieties occur in this locality. The inferior stone from the top courses or strata sells in Lockport, delivered, at \$3.00 per cord. The lower beds furnish stone for curbing and street work. The total thickness of the white

\* The Medina gray and mottled sandstones from these Lockport quarries were much used formerly, and many of the older buildings in the lower part of the town are constructed of them. And they afford the best evidence of the durability of the Lockport sandstone. The quarries here are said to have been opened as early as 1824.

and mottled stone is here, on an average, 10 feet thick. A railway track one mile in length connects these quarries with the main line of the N. Y. Central railroad in the town.

### **Sandstone of the Clinton Group.**

This formation furnishes a building stone in Herkimer and Oneida counties, south of the Mohawk valley and east-south-east of Oneida lake. There are quarries in the towns of Frankfort, New Hartford, Kirkland and Verona. Utica uses the largest part of the stone from the quarries at Clinton and those on Frankfort Hill. The Frankfort Hill stone is of dark-gray to red-brown shades of color, medium fine-grained and hard to dress. It is largely used for foundation walls. It is seen in the walls of the Grace P. E. church on Genesee street, and in the Lutheran church on Columbia street. At Clinton sandstone is quarried by Charles Dawes, John McCabe and Michael McDermott. In Verona a small quarry has been opened near the line of the N. Y. C. R. R. The stone is in thin beds and is gray in color. The Rome railroad depot is built of this stone.

At Higginsville an old quarry has been reopened this season by a Utica company, and preparations have been made to do a large business. The locality is on the line of the old Oneida canal and five miles from the Central railroad. There is a light covering of sand on the stone. The upper beds are thin; they increase as they get down; and at the bottom there is a bed four and a half feet thick. The stone is dark-gray to olive-green in color; some in the top beds is reddish-brown. It is hard and is not split easily. About 12 feet of the stone is above the natural drainage. The place has been opened forty years, and most of the stone has been used in Rome. Latterly some of it has been tried in Utica, and it has given satisfaction. It looks especially well when used with limestone trimmings or with Massachusetts red sandstone. A fine example of the stone is the Gilbert mansion on Genesee street in that city, which was erected seven years ago.

### **Hamilton and Portage Groups.**

#### *Hudson River Blue-stone.*

The term "Hudson river blue-stone" is used to designate the blue, fine-grained, compact and even-bedded sandstone, which is so largely employed for flagging in New York, and more or less in all of our Atlantic coast cities and towns. It is extensively used for house

trimmings also, and hence the common name of "Hudson river flagstone," or "North river flagstone," is not quite as comprehensive as that of "blue-stone." The belt of country in which it is quarried is nearly 100 miles long in New York, stretching from the south-western towns of Albany county, across Greene and Ulster and the western part of Orange and eastern part of Sullivan counties to the Delaware river. In Albany and Greene counties it is narrow, as also in Saugerties in Ulster county, making the foot hills, as it were, on the east and east-south-east of the Catskill mountains, and bounded on the east by the older limestone formations. It widens in the towns of Kingston, Woodstock, Hurley, Olive and Marbletown, and in them the quarries are distributed over the 500-foot plateau which borders the mountains on the south-east. To the north-west, and in the valley of the Esopus creek, many localities near the line of the Ulster & Delaware railroad have been opened and worked. They are a part of the blue-stone district geographically, although the geological formations are not the equivalent of the main belt at the south-east. There are scattering localities in the towns of Rochester and Wawarsing and thence south-west, in Sullivan county which furnish blue-stone for local markets, and for exportation where they are situated near enough to lines of shipping.

The belt, as above described, has in it outcrops of shales and sandstones, belonging to the several geological formations, from the Hamilton period to and including the Catskill, in short, rocks of the Upper Devonian age. There are quarries along the Hudson river at New Baltimore, and thence southward, at Coxsackie and Catskill and near Rondout, but they are not in the typical blue-stone, but in the sandstone of the Hudson River slate formation. The quarries of Palenville and vicinity, of West Saugerties, High Woods, Boiceville, Phoenicia, Woodland Hollow, Shandaken and Pine Hill are above the horizon of the Hamilton formation and probably all in the Catskill group of rocks. The Oneonta sandstone, which is the equivalent of the Portage group, may form a part of the belt near the foot of the mountains, but it is impossible to define its limits and to designate the quarries in it. The quarries at Roxbury and Margaretville and their vicinity, are in the Catskill formation. And the openings along the Monticello railroad, in Sullivan county, are probably in the same horizon. The main blue-stone belt, where it has been so extensively opened, as in the towns of Saugerties, Kingston and Hurley, is of the Hamilton period. And it is significant that it



should have been so productive a region. And if a part be of the Oneonta or Portage, the remarkable fact comes out that they are in the same geological horizon as the great quarries of Ohio stone (Berea and Amherst).

Beginning at the north-east, there are small quarries at Reidsville and Dormansville, seven miles west of the Hudson river, and in Albany county. They have furnished a great deal of stone for flagging in the city of Albany. The stone of these quarries is gray in color and rather coarser-grained than the typical blue-stone of the Hudson river quarries.

In Greene county there are several small quarries near Leeds, which are worked mainly for the Catskill market. In the vicinity of Cairo stone is quarried at several places, and shipped by rail. On the line of the Stony Clove & Catskill Mountain railroad and along the Kaaterskill railroad quarries have been opened, from the mountain houses to Phœnicia. The quarries at Kiskatom and Palenville are not so actively worked as in former years. Their stone goes to Malden, seven to nine miles distant.

Ulster county is the largest producer of blue-stone, and the aggregate output of its many quarries exceeds the combined product of all the other counties in the belt or blue-stone territory. Its quarry districts may be grouped as follows :

1. Quarryville, in the northern part of the town of Saugerties.
2. West Saugerties, in the western part of the town of Saugerties.
3. High Woods, in the town of Saugerties.
4. Dutch Settlement, in the town of Kingston.
5. Hallihan Hill, in the town of Kingston.
6. Jockey Hill, in the town of Kingston.
7. Dutch Hill, in the town of Kingston.
8. Stony Hollow, in the town of Kingston.
9. Bristol Hill, in the town of Hurley.
10. Morgan Hill, in the town of Hurley.
11. Steenykill, in the town of Hurley.
12. West Hurley, in the town of Hurley.
13. Marbletown, in the town of Marbletown.
14. Woodstock, in the town of Woodstock.
15. Broadhead's Bridge, in the town of Olive.
16. Shokan and Boiceville, in the town of Olive.
17. Phœnicia and Woodland Hollow in Shandaken.
18. Fox Hollow and Shandaken in Shandaken.

19. Pine Hill in Shandaken.

20. Rochester and Wawarsing quarries in valley of Rondout creek and its tributaries, north-west of Wawarsing and Ellenville.

Of course it must be understood that there is much variation in these many quarries, in the thickness and nature of the overlying earth and cap-rock, or what is generally termed the "*stripping*," in the number and thickness of the workable beds, in their "*lay*" or dip, in the direction and spacing of the joints or "*headers*" and "*side seams*," in the kind of stone and in the natural advantages of location for economic working. The many openings and their history seem to show that the whole territory is underlain with beds of blue-stone, but in large areas the stone is of inferior quality, or the thickness of quarry beds is not great enough to warrant their working with profit. And the abandoned quarries are the localities generally, where the *stripping* has become too great for removal, or where the stone has thinned out or has been, as it were, replaced by worthless rock. In some cases the localities are left on account of too long haulage to transportation lines. The tendency of later years has been toward railway or canal to save cartage, and the back districts have decreased in their production. Thus there has been an increase in the number of localities opened and in the output of the territory adjacent to the Ulster and Delaware railroad. In practice it is found that where the distance exceeds ten miles, quarrying is scarcely profitable, unless in exceptional cases. And so with the *stripping*, where it is over 20 feet, the quarry beds must be thick and the stone of good quality to pay for its removal. A rule is that the total thickness of quarry beds must not be less than one-third of the *stripping*.

The stone of the Saugerties quarries is carted to Malden and to Saugerties. The quarry districts in Kingston ship their stone from Wilbur, on the Rondout creek, or load on cars at Stony Hollow.

Some of the Hurley quarries also send their stone by team to Wilbur. For the other districts in the towns of Olive, Woodstock and Shandaken, the Ulster and Delaware railroad is the natural outlet line. The quarries near Ellenville and Wawarsing are nearer to the Delaware and Hudson Canal, and the N. Y. O. & Western railroad, and the greater part of their stone is shipped to New York and other points.

In working, the general custom formerly was, to lease the land at

a certain royalty per square foot of stone taken out, about a half a cent per square foot, but now the rate ranges from five to ten per cent royalty. Few of the quarries are run by companies or on a large scale. Nearly all of them are worked by a single party or by the associated effort of two or three men of small capital, or more often by laborers themselves uniting their labor. Hence little or no machinery is to be seen at the greater number. Generally a loading derrick, worked by hand-power and a small hand-pump make up the equipment. At the larger quarries horse-power derricks, for lifting the stone from their beds, and loading derricks at the railroad dock, are in use. The quarries in the Esopus creek valley and in Woodstock are nearly all in steep hillsides and the drainage is natural. And in nearly all of the quarries in the lower country the situation is such that little or no water has to be raised.

In quarrying the rock is thrown down or broken up by the use of common, blasting powder, until the quarry beds are reached. The latter are split apart into convenient sizes by the use of plug and feather wedges, driven in shallow holes, set in lines across the block. The natural division planes, or joints are taken advantage of in cutting up the blocks. These joints are generally vertical, or nearly so, and run in two systems, the one parallel to the strike of the beds, or the ledge also, and the other system at right angles to the first and in the line or direction of the dip of the beds. The former make the successive "headers" or face of the quarry; the latter are known as the end joints. The average distance between the latter is from 10 to 20 or 30 feet. Where they are regular and well defined, as they are in nearly all of the larger quarries, the blocks or slabs of stone are readily cut into rectangular-shaped sizes for platforms, sidewalk, crosswalk and curbing stone. The beds of stone range from an inch to three feet in thickness, and in some instances six feet, as at Quarryville, the top beds generally being thinner than those deeper in the quarry. In working into the hills the bedding planes or divisions sometimes disappear and two or more thin layers coalesce into one thick bed. In most cases these thick strata can be split along planes parallel to the bedding. And the cap layer is lifted off by means of wedging on the edges. The size of blocks is determined by the natural joints, and stone 60 feet by 20 feet have been lifted from the bed. The facilities for handling and shipping limit the size. It is customary to use the thinner stone for town or village sidewalks. The thicker stone are cut into curbing, or crosswalk and sidewalk, or



what is known, as *flag-stone*. The heavier beds make the large platforms or heavy flagging for cities. But some of it is cut into dimension stone for water-tables, sills, lintels, posts and window caps, or for house trimmings in general.

The stone obtained in these several districts varies in color, hardness and texture and consequently in value, from quarry to quarry, and even in the same quarry opening. In nearly all of the localities the beds vary a little from top downwards; rarely is there much variation horizontally, or in the same bed. Hence any given bed may be said to have a certain character, that is, produces a given grade of stone. The color is predominantly dark-gray or bluish-gray, and hence (more by contrast with the red sandstones) a "blue-stone." Reddish-brown and some greenish-gray stones occur in the quarries higher in the mountain sides, as in the valley of the Esopus creek above Shokan and in the Palenville quarries. There is a decided preference for the typical "blue-stone" over the reddish or brownish-colored grades. In texture the range is from the fine, shaly or argillaceous to the highly siliceous and even conglomeratic rock. Interstratified with the workable beds in all quarries there are shaly layers which crumble and fall to earth in time, when exposed to the atmosphere. The cap-rock is often thus, in part, shaly, and thin layers of shale between the heavy sandstone *lifts* are common. The best blue-stone is rather fine-grained and not very plainly laminated, and its mass is nearly all silica or quartz, which is cemented together by a siliceous paste and contains very little argillaceous matter. Hence the stone is hard and durable and has great strength or capacity of resistance to crushing or compression. Coarse-grained sandstones and even fine conglomerates occur and are quarried in some localities. It should be stated here that little of the sandstone is loosely cemented together and friable; and it is rarely open and porous.

The "blue-stone" territory south-west of Ulster county is confined to a narrow belt crossing the towns of Mamakating, Thompson, Forestburgh and Lumberland in Sullivan county, and Deerpark in Orange county. And there are quarries near Westbrookville, near Wurtsborough, along the Monticello railroad and on the Delaware river at Pond-Eddy and Barryville. The last mentioned place is famous for the large size of the flag-stone sent to New York city for the Vanderbilt property.\*

\*They came from Barryville; as follows: . . . . 1— 26 feet x 15 feet 4 inch x 7 inch.

|  |                               |   |
|--|-------------------------------|---|
|  | 1— 10 feet x 15 feet 1        | " |
| Afterwards quarried sizes as follows: }  | . . . . 1— 15 feet x 17 feet  | " |
| 20 ft. x 30 x 10 ft.—"Hickock quarry," } | . . . . 1— 18.6 ft. x 15 feet | " |

North-west of the belt of country above described, flag-stone is obtained along the lines of the N. Y., O. & Western railroad, and of the Ulster & Delaware railroad at Westfield Flats, Trout Brook, East Branch, Margaretville, Roxbury and Grand Gorge, and in lesser amounts at other localities. As it comes to the market with that of the quarries in Ulster county, it is included in the "blue-stone" production. All of these quarries are in the Catskill group of rocks and the stone is more generally a reddish or a brown-tinted sandstone. As a rule it is more *open-grained* and not so dense and strong as the Ulster county stone. A well-marked division is the watershed or divide between the Hudson and the east branch of the Delaware river. The "blue-stone" belt cannot be said to extend beyond the head waters of the Esopus, the Rondout and the Neversink, or, in other words, is confined to their drainage valleys.

As has been indicated, the product of the blue-stone territory reaches the market by the Hudson river (boats), the Ulster and Delaware, the New York, Ontario and Western, and the New York, Lake Erie and Western railroads and the Delaware and Hudson canal. The principal shipping points are Malden, Saugerties and Kingston (including Wilbur and Rondout). A great deal of stone is cut for house trimmings in mills at Malden, at Broadhead's Bridge, West Hurley, Wilbur, Kingston and Rondout, but, probably, the larger number of feet are sent into market, simply quarry dressed, for flagging and curbing. It is the flagging *par excellence*. All the residents of New York city and the adjacent towns in New York and New Jersey, recognize its superiority for sidewalks, crosswalks and for curbing. It so compact as not to absorb moisture to any extent, and hence soon dries after rain or ice; it has the hardness to resist abrasion and wears well; it is even-bedded, and thus presents a good and smooth natural surface; and it has a grain which prevents it becoming smooth and slippery as some of our granites, our slates and our limestones, when so used, in walks. It is strong, and is not apt to get broken. But owing to the many thin beds and the use of too thin stones, sidewalks often become unsightly and bad because of breaks, a fault common to all flag-stone when laid in such thin beds or blocks.

For use in houses and business buildings Hudson river blue-stone is having an increasing market. It is admirably adapted for lintels, window caps, sills, door steps, water tables, etc., with brick, both because of its strength and its durability. None of our sandstones

from other districts, and not even our best granites, are as strong to resist transverse pressure or strain. Tests (comparative) show that it is fully three times as strong, in this way of resistance, as granite, marble, Ohio sandstone and Connecticut and New Jersey brown-stones. To resist compression it is not much superior to these sandstones, and not equal to the best granites. And its strength against transverse strains fits it for lintels, sills, caps, and water tables especially. The use for house-trimming material is increasing as compared with what is sold for flagging and curbing or for street work. And the mills in the district are increasing their product from year to year. The output of blue-stone in 1887 is estimated at 6,500,000 feet.\*

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MONROË, ORANGE COUNTY.—Quarries for flag-stone are opened on the southern end of Skunnemunk mountain, near the Seven Springs Mountain House, and three miles north-west of Monroe. The strata are thin and lie nearly horizontal. The stone is gray, coarse-grained and rather hard and brittle and there are too many thin beds. The quarries are no longer worked, excepting to meet the occasional wants of the neighboring country.

HUNTER'S LAND, SCHOHARIE COUNTY.—Blue-stone for flagging is quarried at several places in the vicinity of Hunter's Land, south-east and east of Middleburgh. The quarries are in side hills, and the strata lie nearly horizontal, and they are in the Hamilton formation. Their output is carted to Middleburgh, whence it is shipped by rail to Albany, Troy and cities in the eastern States. This group of quarries may be considered as a part of the blue-stone district, although not in the Hudson river belt. The formation is the same, and the stone are similar in appearance and texture, and they are only separated by the narrow divide between the watersheds of the Mohawk and the Hudson rivers.

Small quarries for flagging for local uses have been opened at EMINENCE, a few miles south-west of Middleburgh.

OXFORD, CHENANGO COUNTY.—The quarry of F. G. Clarke & Sons is north-west of Oxford village, on the west side of the Chenango valley, and at an elevation of 150 feet above the railroad. The rock is covered by from 25 to 30 feet of drift earth, in which are large, imbedded boulders. The opening is on the west side of and

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\* See appendix for full statistics.



above the stream, so that the drainage of the quarry is natural. It was first opened ten years ago. The drift earth is broken down by blasting, and is carried away in cars on a tramway to the dump near the bottom of the ravine. The face of the quarry is about 500 feet in length, from north to south, but the working is confined to 300 feet at the south end. The *stripping* is done in the winter season, after the quarry work is over. As the excavation moves westward, and into the hillside, new strata appear at the top, and thus the total thickness of the quarry beds is increased so much. The strata are horizontal. A remarkably regular series of joints are in the upper courses or *tiers* of stone, in an east-north-east direction, and they are from 15 inches to 23 feet apart. They do not go down into the thick-bedded stone at the bottom, which is known as *liver-rock*. Some of them are close and are known as "silver" joints or seams, the surfaces being coated with calcite; others are filled with mud (mud joints or seams) in thickness from two to four inches. Cross seams or headers are rarely seen. The top stone, for a depth of 10 feet downward, is thin-bedded and shaly in part, and is practically waste and is thrown out on the dump. Some of it would answer for common walls or rubble work, but owing to the lack of a market, it is not used. Then there are beds which are from four inches upwards, thick, and having a total thickness of 10 feet, which are used for platforms. Stone 22 feet long by 10 feet, or as wide as can be shipped, can be obtained. And the surfaces are very smooth; they make admirable platform stone. At the bottom there are two thick beds, each 4 feet thick, which are known as *liver-rock*. They are cut by channelling machine. The stone has a blue shade in color, and a homogeneous texture, and is capable of receiving fine dressing. At the bottom there is a bed of hard, blue stone, which has not been tested. This quarry might go deeper without sinking below the level of the water. A crushing test of the strength of this stone, made in 1884, showed a resistance of 12,152 to 13,472 pounds to the square inch. The equipment consists of one derrick for removing the stone from the drift earth, one derrick in the quarry and one on the dressing grounds (all of which are worked by horse power), one boiler-house, one Ingersoll channelling machine, and one steam drill. Works for sawing and dressing the stone, to be run by steam power, are now in course of erection, not far from the quarry, and in the village. The stone is carted to the D., L. & W. railroad, three-quarters of a mile away. The principal market is New York city, and the output the

last year was large. The price for the best stone averages about 90 cents per cubic feet. Among the examples of buildings of this stone may be noted: the Aldrich Court building on Broadway, New York city; and St. Lawrence hall, Yale University, New Haven, Conn. With increased facilities for quarrying and a dressing works the output promises to be larger than heretofore.

The stone is known as the "Oxford blue sandstone," although in color it has a greenish-gray tinge. It is geologically in the Oneonta formation. In the more shaly beds plant remains are often observed. This quarry was first opened ten years ago.

COVENTRY.—F. G. Clarke & Sons have another quarry, four miles south-east of Oxford and in the town of COVENTRY. It was opened in 1885; and is one mile from the railway station. The stone here quarried is nearly all cut into flagging; but a little is carted to Oxford and used in foundation walls. It is fine-grained and of a bluish shade of color.

Four miles west of Oxford stone is quarried by Berry Loomis and Walker Brothers. The product is mainly flagging, which is loaded on the cars at Coventry station. About a dozen men are employed in these quarries.

SMITHVILLE FLATS.—Formerly flagging of large size and in heavy beds was quarried at this place, on lands of Mrs. Harrison, but the distance to railroad, eight miles, and low prices, have prevented further working. And the quarry has been idle for two years.

GUILFORD.—Flag-stone is quarried by several parties at New Berlin Junction, on the N. Y., O. & W. R. R., in the town of Guilford. The average number of men employed is about six for the year. The stone is sold at Syracuse.

ONEONTA, OTSEGO COUNTY.—A small quarry supplies the flagging and some common, building stone which is wanted in the town. It is a thin-bedded, blue sandstone.

COOPERSTOWN, OTSEGO COUNTY.—A quarry in the sandstone of the Hamilton formation, and on the eastern side of Otsego lake, is worked at irregular intervals, to fill orders for localities within easy hauling distance. The stone is fine-grained, and is easily dressed. It is used for foundation work mainly.

GOODYEAR'S, CAYUGA COUNTY.—Two miles east of Cayuga lake and Atwater station J. G. Barger quarries flagging and building stone in the Hamilton formation. The covering on the quarry beds averages eight feet in thickness. Then there is flagstone in five *lifts* ; then shale, about 2 feet thick ; then two beds, each about 2 feet thick separated by shale ; or in the aggregate, 6 feet of quarry beds and 12 feet of waste. The stone is carted to the railroad station on the lake shore. The greater part is cut into flagging ; the stone unsuited to flagging is for building. Some of it has been cut and rubbed for house work, at Cayuga, at Parker's Glen, Pa., and also at works on the Hudson river. The principal markets are at Seneca Falls, Canandaigua, Utica, Rochester and New York. The quarry was opened first in 1864.

TRUMANSBURGH, TOMPKINS COUNTY.—Near Trumansburgh several quarries have been opened in sandstone, mainly for flagging. The most important one is that of the Flagstone & Building Stone Company, one mile east of the village, and three-quarters of a mile from the shore of Cayuga lake. The quarry is on the right bank of the Trumansburgh creek, and has a length of 500 feet, from east to west, and a breadth of 250 feet, approximately. Its average depth is 25 feet. There is no *stripping* of consequence, as only two inches of soil covers the rock. The beds at the top are somewhat shaly. Common building stone is obtained from them. The thinner beds at the bottom are used for cutting into dimension stone. The total thickness of the strata is 25 feet, which range from one foot thick down, of which only about seven feet ; or less than 30 per cent, are used. The dip is very slightly north-west. One very regular system of joints is vertical, and at spaces six to eight feet apart, and runs 2° west of north. The quarry has a natural drainage. The stone is carted to a dock on the lake, and shipped by boat to the company's yard at Mott Haven, New York, or to Cayuga, where it is cut into lintels, sills and curbing, and then shipped to New York. It has a grayish shade of color, is fine-grained, and is readily cut into dimension stone for house trimmings and curbing. In the winter season the work of *stripping* is carried on. About 20 men are employed, and a large amount of flagging is taken out.

A few rods west of this opening, a brownish-colored sandstone crops out, and which is opened and quarried for building stone. It was used for the Protestant Episcopal church in the village. Some



of the blocks have natural faces, and are of a dirty yellow shade in color. Others show a reedy structure.

Near Halseyville and a half a mile east of the Trumansburgh and Ithaca road there are quarries on both sides of the Taughannoek creek, worked by D. S. Biggs. On the south side of the stream the *stripping* of earth is 18 feet thick, and on the north side 10 feet thick. The beds are horizontal, with vertical joints at convenient distances apart for working. From the north quarry more flag-stone is obtained; from that on the south side more building stone. None of the strata are more than 18 inches thick, and shale is interbedded with the stone, but all of them split readily into slabs and flag-stone of convenient sizes. On account of the shaly rock there is much waste in these quarries. The drainage is natural. Two small derricks comprise the equipment. The flag-stone are carted two miles to lake, but the railroad station is only a half mile away. This quarry was opened in 1884.

A short distance down stream, on the right side is Dumont's quarry for flag-stone, and near it is still another small quarry. All of these quarries sell stone to the works at Cayuga, whence it goes to Syracuse, Geneva, Rochester, etc., besides the local markets.

In Kingtown, a hamlet in the town of Covert, there are two small flag-stone quarries, which are worked as the demand calls for stone. Only a few men are employed in each.

ITHACA, TOMPKINS COUNTY.—Sandstone is quarried on the hill south of the town, at two places by G. C. McClune. The older quarry is one mile south of the corporation line and about 200 feet above the valley. The *stripping* is mostly shale and some rough stone, the best of which is used for common walls. The flag-stone layers are from 14 inches to 28 inches thick, and from 5 to 12 layers of the flagging, from 1 to 8 inches thick, are obtained. The strata dip at about 1 in 24, southward. The quarry was opened in 1838; and it has yielded a large amount of stone. The other quarry is 80 rods easterly from the first and within three-quarters of a mile of the town line. It was opened in 1875. The beds are more irregular and the stone is not so fine-grained as in the other. These quarries furnish flagging for Ithaca and vicinity.

Sandstone for the Cornell University buildings was quarried on the site of Cascadilla Hall, and at a quarry in front of the main building, but lower on the hillside. Another quarry was opened near the

McGraw-Fisk mansion and Fall Creek. The stone in Cascadilla Hall is the best from these local quarries.

The Ithaca stone is fine-grained and has a greenish-gray tinge. Natural face blocks are apt to show stains and look rusty or dirty yellow. When selected with care and dressed as rock-face ashlar it makes a substantial looking building. Nearly all of the foundation and basement-wall stone in the place are from these home quarries. When in rough-pointed or crandalled blocks in course work it looks well.

The geological horizon of these quarries is Portage.

WATKINS GLEN, SCHUYLER COUNTY.—A sandstone in the Portage group is here opened and worked by the Northern Central Railroad Company, for its construction on its lines both north and south. The stone is reported to be fine-grained and evenly-bedded.

PENN YAN, YATES COUNTY.—Sandstone for foundation walls is quarried near Head street, by Geo. R. Cornwell; and at Thayer Bros. quarry, on the east side of the lake, three miles from Penn Yan.

PORTAGE, LIVINGSTON COUNTY.—The quarry of Peter Pitkin is located two miles south of Portageville and three miles from Portage station on the N. Y., L. E. and W. R. R. It was first opened many years ago, but reopened by Mr. Pitkin in 1883. It is on the west side of the valley of the Genesee river, and a few rods only west of the track of the B., N. Y. & P. R. R. The principal excavation is rectangular in shape, 109 feet long and 43 feet wide, being determined by the wonderful regularity of the vertical seams. The north-east, south-west and south-east sides are simply joint faces, and the breadth of 43 feet measures the space between two of these vertical seams or joints. A second system of joints runs north-north-east and south-south-west, and dips 80° west-north-west. The *stripping* or covering of earth is nine feet thick on the east side and 25 feet thick on the west side. A part of this *stripping* is of the nature of quick-sand, and slides are very apt to occur, especially in the spring of the year, carrying earth, sand and stone into the quarry. The beds are horizontal so far as can be observed in the quarry. Generally they are separated by thin layers of mud or earth. A vertical section shows the following order in the strata :

- |                    |                  |
|--------------------|------------------|
| 1. Sandstone ..... | 6 feet 4 inches. |
| 2. Sandstone ..... | 4 feet 6 inches. |
| 3. Sandstone ..... | 2 feet 0 inches. |

|                            |                  |
|----------------------------|------------------|
| 4. Sandstone.....          | 1 foot 4 inches. |
| 5. Sandstone.....          | 1 foot 6 inches. |
| 6. Sandstone.....          | 2 feet 0 inches. |
| 7. Sandstone.....          | 3 feet 0 inches. |
| 8. Sandstone.....          | 2 feet 0 inches. |
| 9. Sandstone.....          | 1 foot 1 inch.   |
| 10. Sandstone.....         | 1 foot 9 inches. |
| 11. Sandstone (bored)..... | 2 feet 1 inch.   |

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27 feet 7 inches.

The quarry beds together have a thickness of 25 feet. The best stone of the quarry has an olive-green shade of color, is fine-grained, homogeneous in texture, and soft enough to dress well and to be easily cut. It is said to harden on exposure to the weather. Some of the stone, which is known as second grade, contains vertical fillings of annelid borings. The equipment of this quarry consists of two derricks for loading stone, one for hoisting stone in the quarry, one Ingersoll channelling machine, one steam drill and one steam pump. A side track runs to the quarry.

The greater part of the stone quarried here is shipped direct by rail to New York city, where it is worked up into house trimmings. The second grade of stone is sent to Rochester, where it is worked at the Pitkin stone yard. There is very little water, excepting in the spring. The caving in on the upper side makes the uncovering expensive. The quarrying season continues, on the average, about seven months. The Portage stone, like the Warsaw blue sandstone, is harder than the Ohio sandstones, but not as hard as the Medina. That they are not as durable as the latter is evident from their composition. The Aldrich Court building on Broadway, New York, has the Portage stone in the trimmings of the first and second stories.

**WARSAW, WYOMING COUNTY.**—A sandstone known in the market as "Gainesville blue sandstone," has been quarried for many years in the town of Gainesville, and near Rock Glen station, south of Warsaw. It was reopened the past season by the Warsaw Blue Stone Company; and preparations are being made to develop the property, and increase the output. A mill for sawing and dressing the stone is in course of erection. The quarry is on lands of E. E. Farman, and is on the west side of the valley. As opened, the vertical section includes the following members :



1. Earth and stone in fragments..... 8 feet.
2. Sandstone, with annelid borings..... 2 feet 4 inches.
3. Quarry beds of sandstone, from 18 inches to  
4 feet thick..... 8 feet.

The ground rises west of the quarry, and new beds come in at top, as the excavation advances into the hill. A side track runs to the quarry from the line of the N. Y. L. E. & W. R. R. The drainage is natural. Steam derricks and a complete quarry plant have been set up. The stone is very fine-grained, harder than the Ohio stone, and has a bluish-gray shade, and is said to retain its color. It has been used for over thirty years in Warsaw and vicinity, for monumental bases and for buildings. The Smith & Perkins block on Exchange street, and the first story of the City Hall in Rochester, and the *Alpine*, on Broadway near Thirty-fourth street, New York city, are examples of its use in construction.

### Chemung Group.

WAVERLY, TIOGA COUNTY.—Sandstone is quarried in the vicinity of Waverly by M. L. Bogart and John H. Murray.

Bogart's quarry is about 40 rods from the G. I. & S. R. R. line, and two miles north of Waverly. It is opened in the face of a hill, and the back of the quarry has a height of 80 feet. There is about two feet of overlying earth, on the average. The beds range in thickness from two inches to two feet, averaging about a foot. The stone is blue to gray in color. It has been used in bridge building on the line of the D. L. & W. R. R. Co., and in several business blocks in Waverly, East Waverly and South Waverly. The quarry was opened in 1870.

John H. Murray's quarry is in Chemung county, and one and three-quarter miles from railroad depot at Waverly. The *stripping* is three to six feet thick, and the average thickness of the quarry beds, one to three feet. The stone is a gray sandstone. It has been put into foundations and basements in Waverly. The quarry has been opened thirty years.

ELMIRA, CHEMUNG COUNTY.—There are four quarries near the city and opened in the western face of the hill, which here bounds the valley. One of them is worked by a large force, that of A. D. Simon. It is opened for a length of about 600 feet from north to south, and is back at least 200 feet in the hillside. The maximum height of the face is 100 feet. Earth covers the rock to an average depth of nine

feet. Then the sandstone and shale, in irregularly alternating strata, are found quite to the bottom of the quarry. The heavier beds and the best stone for building, are in the upper 30 feet. And the present quarry operations are on a floor, which is only 40 feet or so below the top. The strata appear to be nearly horizontal; and range from 2 inches to 2 feet in thickness. The rock is conveniently divided by two systems of vertical joints, which run north and south and east and west. The stone is fine-grained and has a gray to greenish-gray color. In working, deep holes are sunk, and by means of large blasts great masses of stone are thrown down. They are broken into convenient sizes for building. The stone is all sold in the rough, and no cutting or dressing is done at the quarry. The larger part of the product is used in Elmira for building and a small part for curbing. The stone averages about a dollar a perch in the city. The plant includes one derrick, a steam-drill, boiler-house and shop, and the teams and wagons for the carting of the stone into the city. A large force of men is employed, quarrying in the warm season and *stripping* in the winter. The quarry is only a mile from the D. L. & W. and the N. Y. L. E. & W. R. R. depots; and is about 150 feet (at top) above the valley.

North of Simon's quarry, and in the same range, three quarries have been opened in the steep hillside, at elevations of 250 to 300 feet above the city. That of John McGreevy has a working face 180 feet long, a breadth of 75 feet and a height of about 40 feet, at the back. There are shales and sandstone here also, and rather more of the former. In the next opening, 50 feet beyond, the working face is 450 feet by 60 feet in height. The vertical section includes earth from 5 to 8 feet thick; shale and a little sandstone intermixed, 5 to 8 feet; then, shales with beds of sandstone from an inch to a foot thick, for 50 feet. About 75 per cent of the mass is shale; and hence waste. About 100 yards to the north there is a third opening, which has a length of 600 feet and a height of 60 feet. Here also the proportion of shale is large. The beds in these quarries are horizontal. Joints divide the rock vertically and make the work of quarrying easy. And much of the stone has the natural joint faces; and they are usually of a dirty-yellow to brownish shades of color. The stone is fine-grained and hard, but not very durable.

These three quarries are not much worked. The amount of waste offsets the advantages of natural drainage and the convenient locations for waste dumps and the nearness to city and railway.

These Elmira quarries are in the Chemung group, geologically viewed.

CORNING, STEUBEN COUNTY.—There are three quarries at Corning, in the valley south of the town, and on the hillside about 250 feet above the bottom of the valley. That of B. M. Payne is on the west side of the valley; and has been opened for a length of 300 yards or more from north to south-west. Its face is 20 to 40 feet high. At the top the earth and shaly beds have an aggregate thickness of 10 to 20 feet, although there is some good stone in these courses. Below, there are 15 feet of beds of sandstone, interstratified with shaly beds. They range from 1 foot to 2 feet in thickness. Two systems of vertical joints, at right angles to one another, are noticed. The stone is grayish-green in color and fine-grained. The quarry was opened in 1855, and has produced a very large amount of stone. It has not been worked during the past season.

John Kelley's quarry is south of and across the road from Payne's quarry. Its working face is 400 feet in length, fronting south-east. The *stripping* consists of earth and shaly rock, together 10 feet. Then come beds of various thickness, from 4 inches to  $2\frac{1}{2}$  feet. Some of the shaly rock is interbedded with the sandstone, more or less all the way down to the bottom of the quarry. At the bottom there is a layer 1 foot thick, of soft, blue stone, and underneath it hard, iron-stained rock. The total thickness of workable beds is 30 feet. There is a slight dip in a south-westerly direction. One main system of joints runs north  $80^{\circ}$  east; a second system runs south  $30^{\circ}$  east. They are vertical and usually, are open or mud-filled, and at spaces of 15 to 20 feet apart. As the quarry is on the hillside there is no pumping or raising of water. Two horse-power derricks are in use, and the stone are carted to Corning depot, three-quarters of a mile or to the D. L. & W. Railroad line, two miles distant. The Fall Brook Coal Co.'s railroad also is reached at about one mile from the quarry. In the winter season the *stripping* is carried forward, so that the work continues throughout the year. A large amount of stone from these quarries has been used on the Fall Brook Coal Co.'s Railroad line for bridge work. It is sold for common wall work and foundation walls in Corning, at \$1.50 per cubic yard, delivered.

H. C. Heerman's quarry is south-east of the Payne and Kelly quarries and on the opposite side of the valley, and about 50 feet above the bottom of the ravine. The opening is large and the *stripping* is thick, as at the quarries above mentioned. The workable



beds of sandstone are from 1 to 3 feet thick, and are interbedded with some shale. It is not worked.

At the south of the town and on the north point of the hill an old quarry has been reopened lately by A. D. Simon, of Elmira, for rip-rap work on canal in Corning.

The stone of the Corning quarries has been used in Elmira, in the Congregational church and in the State Reformatory buildings.

In Corning the old Arsenal; the R. C. church; First Presbyterian church, and the Prot. E. church buildings, are all of this stone. In the Arsenal building, which was erected thirty years ago, the stone shows some signs of age, owing to bad selection. The best example of the Corning stone can be seen in the basement of the High school, and in the basement story of the residence near the public school. In the latter great care was taken to select the large and best colored stone in the quarries.

DANSVILLE, LIVINGSTON COUNTY.—The quarry of Frank Schubmehl. This quarry is one mile north-east of Dansville. The opening has a working face 250 feet long, and the *stripping* is clay loam, two feet thick. The beds lie nearly horizontal, and there are no regular joints. There are six courses or beds, which average 18 inches thick, and ten feet of courses, which are three to six inches thick, making a total of 19 feet of quarry beds. The stone has a bluish-gray color, is fine-grained and hard, but with it there is a soft, argillaceous sandstone, which is thrown out as waste. This quarry has been opened for about 35 years. It is worked in a small way. The product is flag-stone, common wall stone and cut stone. The Sanitarium, the Methodist church, and the Union Free school at Dansville are constructed of this stone.

COHOCTON, STEUBEN COUNTY.—Theodore Whitney quarries stone on lands of S. M. Woodworth, two miles north-east of Cohocton. The *stripping* is clay, and of an average thickness of 4 feet. The quarry face has a length of 200 feet, and in it there are probably 75 beds, or courses of stone, 20 feet of which are workable. These workable courses vary from two inches to six inches thick. The joints of the quarry run north 5° east, vertical, and the stone is light-gray and bluish-gray in color, with a small part of it reddish-brown. The working season lasts six to seven months, and the output is all for flagging, which is used in the adjacent towns.

**BATH, STEUBEN COUNTY.**—Two quarries of sandstone are worked in the town of Bath. The quarry of W. & Geo. Jincks is one and a half miles north-east of the town. The opening is 300 feet long, and about 20 feet high, with a *stripping* of  $5\frac{1}{2}$  feet. The beds are nearly horizontal. About 20 courses are suitable for common wall work, and two courses do for cut stone. The stone is of a light-gray color, hard and fine-grained. The quarry is worked from about the 20th of May until the middle of September. Curb-stone flagging and common, wall stone are here quarried. The Protestant Episcopal church and the county buildings in Bath, are constructed of this stone.

The Miller quarry is three-fourths of a mile north of Bath. It has a face 150 feet long. The vertical section consists of 3 feet of clay, then shales, 5 to 7 feet, below which are workable courses or beds. Some of the thin beds are used for flagging, and these partly pay for the cost of removing the top rock or the shales and clay covering. The cut stone courses are 2 feet 5 inches, and 1 foot 9 inches thick, respectively. This stone is fine-grained, medium soft, and is of a gray shade in color. The quarry is worked three to four months of the year. The principal market is Bath. The Baptist church, erected this year, is of this stone. It sells in the town, delivered, at 50 cents per perch for wall stone, and \$4.50 a yard for the cut stone.

**HORNELLSVILLE, STEUBEN COUNTY.**—Two quarries are opened and worked in the vicinity of Hornellsville. That of Jos. F. Cobb is located one and a half miles south of the town. The quarry face runs 175 feet and 30 feet back. The *stripping* has an average thickness of five feet. The total thickness of the workable beds is 22 feet, of which three to four feet is somewhat slaty and of little value. The dip is very slightly south, about 1 foot in 70. Two systems of joints divide the rock at right angles to one another. They are vertical and run north  $50^{\circ}$  east, and south  $40^{\circ}$  west. The stone is of a bluish shade in color, hard and fine-grained, and, in some of the beds, clayey. The adjacent outcrops on the steep hillside show that the sandstone beds are a durable stone. The quarry was opened in 1883. It is worked during the summer season. The product is mostly common building stone, and it is cut for the market at Hornellsville. The Park school-house, recently erected, and the electric light building and several stores and residences are built of this stone.

Two miles south of Hornellsville is the quarry of Morris Powers. Its length is 150 feet, and its height at the back 35 feet. The *stripping* is six to seven feet thick, clay and shales mixed. The bedding, the joints and the stone, in color and in texture, are somewhat similar to what is stated above of the Cobb quarry. This quarry was opened in 1881. The output is small. The price for the stone in Bath is 70 cents per perch.

A sandstone was formerly quarried a little in the town at Greenwood, for home supply.

BELMONT, ALLEGANY COUNTY.—William Storr's quarry. This quarry is a quarter of a mile south-west of the village of Belmont. The *stripping* is two to two and a half feet thick, soil and one and a half to two feet of shales. There are seven to eight courses or beds worked. Two of them are used for cut stone. The aggregate thickness of the quarry beds is 12 feet. The heaviest stone is 30 inches thick. There are two sets of joints, one running north 50° east, and another, which is also vertical, making an angle of 70° with the first. The freshly fractured surfaces are light-blue in color; and when cut it has a light-gray shade. It is rather soft and easily dressed. It is worked from the middle of May to the middle of December, and the principal markets are Belmont, Wellsville and Angelica. Vanderhoef's block in Belmont, besides other buildings, are of this stone. The prices range at about \$1.00 per perch for common wall stone to \$4.50 per yard for cut stone; the latter, however, at the quarry.

BELVIDERE, ALLEGANY COUNTY.—The quarry of H. Whitcomb. This place is worked by Alfred Dibble, and is half a mile from the Belvidere railroad station. About one-fourth of an acre has been worked over. The gravel loam covering averages about 5 feet in thickness. The strata lie nearly horizontal. One system of joints runs north 15° west, and is crossed by another nearly at right angles, and both of them are vertical. The beds range in thickness from 18 inches to 3 feet 10 inches. The stone is of a light-gray shade in color, medium soft and dresses readily. It is said that this quarry has been opened for about thirty-five years. It is worked in a small way for six months of the year, and produces cut stone for house trimmings, monument bases, horse blocks, hitching posts, etc., and it is used in Belvidere, Friendship, Angelica, and a little of it in Wellsville and Hornellsville.



**BELFAST, ALLEGANY COUNTY.**—Two miles south of Belfast the only quarry of importance is that owned by Jas. Lang. It is worked to a very slight extent and for the home market chiefly. The Baptist church is constructed of this stone. There are only five or six courses or beds which are worked, of which the lower is the best. The *stripping* is 5 feet thick.

**NEW HUDSON, ALLEGANY COUNTY.**—Flag-stone is quarried in this town, near the west line of Belfast, by Mr. Searle. It is worked to a limited extent. The stone occurs in thin beds, 1 to 2½ inches thick. They have even and true surfaces ; and are considered the best flagging in this part of the State.

**CUBA, ALLEGANY COUNTY.**—An extensive quarry west of the village of Cuba was worked many years ago. The rock is a sandstone, and is in the Chemung group.

**OLEAN, CATTARAUGUS COUNTY.**—The Olean Blue Stone Company quarries a sandstone two and a half miles south of Olean, and near the hilltop, about 700 feet above the Alleghany river. The quarry face has a length of 1,500 feet, and a height of 60 feet, of which there is 20 feet of *stripping*, and 40 feet of quarry beds. The stone is worked into flagging and building material, and is sent to market by rail, being shipped to Olean. The stone is fine-grained, and of a gray to greenish-gray shade of color, although in the market it is known as “Olean blue stone.” The quarry was opened in 1878.

**JAMESTOWN, CHAUTAUQUA COUNTY.**—There are six small quarries in the eastern part of the town, and near the Chautauqua lake outlet. They are from one to one and a half miles north-east of the railroad station. They are worked principally for local supplies. On Allen street, stone is quarried at several points, for cellar walls, and for cut stone, and for house trimmings. These are small openings in the hillside and on rear of the lots.

About a quarter of a mile north-east of Allen street, and on the right bank of the creek, there is an old quarry, whence a large amount of stone has been taken, and which is still worked in a small way. The quarry face measures 40 feet high, including some earth and cap-rock at the top. The upper 20 feet of quarry beds is rather inferior stone, being shaly. The lower beds are thicker, and answer for common walls. About a quarter of a mile beyond, on to the north-east, is the quarry of Ewing, close to the creek. The face is

about 100 yards in length from east to west, and 50 feet high, of which 40 feet is rock. The bottom beds are on an average, one foot thick, and furnish stone for cut work.

The quarry of John McVeigh is on the left bank of the stream, and diagonally across from the last named. Its face looks south, and is 500 feet long and 50 feet high. The strata are horizontal. The upper beds are shaly and irregularly interstratified with thin layers of sandstone, two to ten inches thick. At the bottom, the beds are twelve to twenty inches thick, and they furnish stone for cut work. The top stone is used for common walls and rubble work. The joints or seams are at irregular distances apart. The main systems run north  $30^{\circ}$  west and south  $55^{\circ}$  west, the first being vertical, the second dipping steeply north-west. The *stripping* is three to ten feet thick. The drainage is natural, and no machinery is used. The quarry was opened first in 1852. An old opening 100 yards north-east of Mr. McVeigh's, and at the side of the railroad track, is idle.

A more recent opening is that further to the east, on the right bank of the stream, and on the south side of the railroad track, about a mile and a half from the station. Its face fronts north, and has a length of 50 yards, and a height of 40 feet at the west end, and 30 feet at the east end. A section shows drift earth at the top, five to twelve feet thick; then, shales and sandstone, alternating irregularly, being thicker at the bottom, which is nearly on a level with the creek. The beds are horizontal. One system of joints runs south  $65^{\circ}$  west, dipping  $75^{\circ}$  to  $80^{\circ}$  north-north-west; the second, a vertical system, runs north-west. The upper 20 feet are mostly thin beds of shaly stone. The lower 20 feet are strata from 6 to 12 inches thick.

The stone of these quarries is fine-grained, soft and breaks with conchoidal fracture, and has an olive-green color. It has been used in Jamestown and Chautauqua for foundations, and is dressed for house trimmings. It is largely used for retaining walls also. The formation is Chemung.

Other localities in Chautauqua county are in Panama and west of Chautauqua lake; in the town of Clymer, and near the Pennsylvania line; in Westfield, near Lake Erie; and in Laconia, in Pomfret. But at all of them there is much waste in the shape of shales associated with the sandstone beds.

#### New Red Sandstone.

NYACK, ROCKLAND COUNTY.—Between Nyack and Piermont, on the west shore of the Hudson river, sandstone is quarried at two

points. The quarry of Daniel T. Smith is a half a mile north of Piermont and east of the Northern railroad a few rods. At this quarry the top dirt is about 10 feet thick. The upper beds are somewhat shaly ; then the more solid sandstone comes in thick beds, which alternate irregularly with what are known as "callous veins." Some of the stone has a laminated or reedy structure. The dip is  $12^{\circ}$  west. About 15 feet in thickness in beds is here worked. Lintels, sills, and a little building stone are obtained. These quarries formerly furnished much stone for foundations in the vicinity, and also some for buildings. A house near the quarry, built in 1768, shows the durable nature of the stone. The Cornelius house also is Nyack sandstone.

The quarry of Nelson Puff, in the same range and in the southern part of Nyack, is worked nearly every season for the local market. The top dirt is heavy and the upper beds are shaly. Below, the stone is solid and thick-bedded.

**Haverstraw, Rockland County.**—The sandstone quarries at Haverstraw are in the north-eastern and northern part of the Torne mountain range. They are worked only at long intervals, and for the local market. The stone is rather coarse-grained, and is dark-red in color.

The Demarest quarry, one and a half miles south-west of Haverstraw, is the only one which has been worked of late years.

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NOTE.—For the sandstones of the more recent geological formations see pages 22 and 23.



# LIMESTONE.

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The geographical distribution of the limestone formations in the State and the general reference to the quarries for building stone, which have been opened in them, were given on pages 20-22 of this report. The arrangement of the detailed descriptions of the quarries and quarry districts in the order of the geological series, that is, from the Calciferous, up through the Chazy, Trenton, Niagara, Lower Helderberg and Upper Helderberg, has the disadvantage of separating quarries, which belong together in their geographical and economic relations and of grouping some which are in no wise related, excepting in their position in the same geological horizon. The order of arrangement has been so modified in the following pages as to bring together the quarries in their proper geographical divisions and according to their geological position in these several divisions. It is, therefore, a geographico-geological arrangement. And in it the limestones of the Hudson-Champlain valley are described first ; then, the Calciferous and Trenton limestones of the Mohawk valley ; followed by the quarries in the belt of Trenton, which runs northwest from the Mohawk to the St. Lawrence ; the limestones of the Lower Helderberg formations in Schoharie, Otsego and Madison counties come next ; the Upper Helderberg limestones of Onondaga, Cayuga, Seneca, Ontario, Genesee and Erie counties follow ; and, lastly, the Niagara limestone quarries of Monroe and Niagara counties.

**WARWICK, ORANGE COUNTY.**—A blue, magnesian limestone is quarried in the village of Warwick, on lands of Thos. Burt and others. The quarries are in a hillside. The beds are ten inches to four feet thick, and dip west-south-west. The stone is hard, strong and durable. It has been used for foundations largely, and to some extent for dressed house work in the town. The quarries are not constantly in operation.

**MAPES CORNER, ORANGE COUNTY.**—A blue limestone is quarried in Mt. Lookout, near Mapes Corner, in the town of Goshen, on lands

of the county alms-house and of Wilmot Durland. The stone occurs in thick-beds. It weathers in some blocks to a light-drab to a straw-yellow shade, but it is not unsightly, excepting the variation in a wall due to two or three shades in the several blocks. The locality is worked at irregular times, and by builders who have contracts for buildings. A fine example of the massive appearance of the large, heavy blocks in course work, is to be seen in the Presbyterian church at Goshen. Other structures of this stone are the Methodist Episcopal and Roman Catholic churches in the same town, and the Roman Catholic church in Chester. The quarry was opened about twenty years ago. It is a half a mile from Orange Farm station of the Pine Island Bra. railroad.

NEWBURGH.—Limestone is quarried south-west of Newburgh, near the old Cohecton turnpike, and on the north side of Snake mountain. The Brown Limestone Company has an opening near this road. It is 100 yards in diameter and 30 to 40 feet deep. Although the principal business is the quarrying of stone for lime making, a part of the quarry product is sold for common foundation walls.

West-south-west of the above mentioned quarry, limestone was opened and worked for the West Shore viaduct in the city of Newburgh. At this place the stone is plainly-bedded, and the dip is  $40^{\circ}$  south  $5^{\circ}$  east. The stone from this same range was used in St. George's Protestant Episcopal church in Newburgh. It has been used largely for foundation work and for retaining walls also in Newburgh.

Another Newburgh quarry is north of the city and at the side of the river road. It is small and its output inconsiderable.

NEW HAMBURGH, DUTCHESS COUNTY.—A blue, magnesian limestone is quarried by the N. Y. C. & H. R. R. Co. at the side of their track two miles north of New Hamburg. The beds dip westerly at an angle of about  $30^{\circ}$ . The beds are one foot to eighteen inches thick. The stone is used for bridge work.

KINGSTON, ULSTER COUNTY.—The quarries in the Onondaga Limestone are opened in the city of Kingston on lands of J. O'Reilly, about a quarter to three-eighths of a mile south-west of the Kingston

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NOTE. The so-called *Glens Falls marble*, the *Lepanto marble* and the *Hudson coral-shell marble* will be found described under their respective heads in this section on limestones.

armory. The openings are shallow, consisting in the removal of the top strata from what was originally a ledge, projecting above the general level of the surface. The beds dip  $16^{\circ}$  to  $20^{\circ}$  in a north-north-west direction. Two well-marked systems of vertical joints traverse the rock at right angles to one another. One runs a little west of north and the other north of east. The beds are from 2 to 8 feet thick. The stone is hard, compact, very strong, and of a bluish-black color, weathering to a pale shade, and on exposure to a buff. The weathered surfaces show clay seams, which are from one-sixteenth to one-fourth of an inch thick, and lie in the planes of the bedding. These seams have a yellowish, dirty color, contrasting with the blue, calcareous portion of the mass. Some of the upper layers in this quarry contain black flint or chert, in thin layers; also some scattering pyrite, on the weathered natural surfaces, and occasionally some calcite or quartz. Owing to the bedding and the joints the rock is readily broken into large, rectangular blocks, and thereby the work of quarrying is facilitated very much. The stone is adapted to heavy mason work. Limestone has been obtained at several points in this same lot, from the cemetery on the south-west to Union avenue, near the Kingston & Rondout railroad. The stone for the Poughkeepsie bridge was obtained here. The quarry has been worked by Frank Madden. At the quarry near the City Hall and south-east of Madden's residence, the limestone shows bedding with a dip at a moderate angle to the south-east.

**NOONE & MADDEN QUARRY.**—Limestone in the western part of the city has been opened by Noone & Madden and worked by them. This quarry is about 200 yards distant from Washington avenue and near Pearl street. It consists in the removal of one or two layers from the exposed, outcropping limestone, over an area of several acres, where the natural surface slopes with the dip of the beds, east-south-east, at an angle of  $10^{\circ}$ . The well-marked joints, which are vertical, run north  $10^{\circ}$  east and north  $80^{\circ}$  west. They are at distances convenient for working, and the quarrying operation is simply in lifting the beds or blocks bounded by these joint divisions. This stone also shows clay seams, in lines parallel to the bed, although more irregular than in the O'Reilly quarries. Some pyrite in scattering crystals is observed in the stone. On weathering, they give the surface a brownish or rusty look. The stone from this quarry has been used for the construction of buildings in the city of Kingston. The clay seams make the stone look unsightly, although they do not



impair the strength or durability, except when the stone is set on edge.]

These Kingston quarries are not worked continuously. A large amount of stone was taken from them for the Brooklyn bridge anchorage and piers. It was used in the first bridge over the Hudson river at Albany; in the sea-wall, Battery park, New York; in the dock wall of the Watervliet Arsenal; in locks at Cohoes and Waterford; and in a church at Kingston and in one at Newburgh.

GREENPORT, COLUMBIA-COUNTY.—The crystalline limestone of the isolated Becraft mountain, near Hudson, has afforded a large amount of excellent building stone to the city of Hudson almost from its earliest settlement. The ridge is an outlier in the Hudson river slate territory and its structure is that of an open synclinal fold. Its rocks belong to the Water-lime and Lower Helderberg groups. The quarries are on the northern end and on the western front of the escarpment. The older openings, known as the Berridge quarry, are on the northern foot. They are extensive, but are no longer worked. The quarry of F. W. Jones is further south and higher up; and is about one and a half miles from the railroad station (Hudson), and the same distance from the river. The covering of earth is slight where the workings have opened the beds. The dip of the beds in the northern part of the quarry is  $10^{\circ}$  south-east; in the south opening the dip is  $6^{\circ}$  to  $8^{\circ}$  east-south-east. There are two systems of joints of which one runs south-east, vertically. The beds are from 6 inches to 4 feet thick and somewhat uneven on their surfaces. The stone is gray in color, sub-crystalline to crystalline and highly fossiliferous. It is nearly pure carbonate of lime. It is quite easily dressed and takes a good polish, and the polished surfaces have a variegated, reddish-gray aspect. It has been used to some extent as an interior decorative material, principally in Boston, and is known as "coral-shell marble." The Presbyterian church in Hudson is built of this stone. The quarry work is now mainly for supplying flux to blast furnaces on the Hudson. The location is convenient for economical working, as there is no pumping and the *stripping* is light. The stone is carted to the Hudson station. A branch railway line from the river to the quarry is partly graded. The quarry equipment includes channelling machines, steam drills and machinery for cutting and polishing.

**SARATOGA SPRINGS, SARATOGA COUNTY.**—Blue limestone for common masonry has been quarried at several places in the town, but at no one of them is the business of quarrying continuous. The largest exposure of quarry beds in the town, is north of the Red spring and east of North Broadway about 200 yards. The beds are dipping  $8^{\circ}$  south and are thick, and the stone is light-blue color. For more than 1,000 feet the ledge has been worked. The upper layers, aggregating eight feet in thickness, are quarried. A second ledge, to the west a few rods, has been worked down five feet.

Three miles west of the town limestone is quarried by Chas. Slade, Isaac Wager, Prince Wing and Jas. A. Lee.

The quarry of Charles Slade is located on the gently sloping side of a low ridge which borders on the north the Washington street road. The older quarrying work was done east of the present site. The working face is 100 yards long from east to west, and is 10 to 20 feet in height. The vertical section shows the following order of succession in the beds, from top downwards:

|  |                  |
|--|------------------|
| 1. Boulder-drift earth .....                     | 3 feet.          |
| 2. Hard, thin-bedded, pale blue limestone, ..... | 10 feet.         |
| 3. Dark-blue limestone .....                     | 2 feet 6 inches. |
| 4. Dark-blue limestone .....                     | 1 foot 8 inches. |
| 5. Dark-blue limestone .....                     | 1 foot 3 inches. |
| 6. Dark-blue limestone .....                     | 1 foot 6 inches. |

In the upper 10 feet, and lying immediately upon (3) there is a light-colored bed which is 16 inches thick. The beds dip to the south-west at about 3 feet in 100 feet. The main system of joints is vertical and runs in a south-west course. A system, whose course is at right angles to the first, is vertical also. The joint faces are frequently coated with small crystals of calcite. The top beds are hard and the stone is not easily dressed. The dark-blue stone is softer and is easily worked. Two derricks, worked by horse power, are in use. The quarry now has a natural drainage, but deeper sinking will necessitate pumping. The stone is carted by teams to Saratoga Springs, where it is shipped by rail to destination. The large market is for heavy (bridge) work on lines of the Delaware & Hudson Canal Company. Some of it goes to Saratoga for foundation, retaining walls, etc. This quarry was first opened ten years ago.

Prince Wing's quarry is at Rowland's Mills, and on the south bank of the stream. And the beds here exposed lie above those in Slade's

quarry. A face 400 feet in length and 20 feet in height shows the stratification finely. The beds are thin, and there is some black shale interstratified with the limestone, and the formation is of the Trenton age. This quarry is worked mostly for lime manufacture.

Isaac Wager's quarry is one-third of a mile east of Rowland's Mills, and on the north side of the stream. Here also the beds of limestone dip a few degrees, and to the south-south-east. The covering on the stone is a clay-loam and "hard pan," which varies in thickness from two to seven feet. Then follows the limestone, in beds from 8 to 20 inches thick, for a total thickness of eight feet. The quarrying work moves northward and up the dip plane. Only a few men are employed, and the stone is drawn by teams to Ballston and to Saratoga. It is sold mostly as cut or dressed stone, and for house trimmings and for curbing. It can be seen in the Lathrop houses in Saratoga and in the Wiley building in Ballston.

The quarry worked by Jas. Lee is about 300 yards east-north-east of that of Wager and within a quarter of a mile of that of Slade. It is a small opening and is worked at irregular periods to suit demand. A thin covering of sandy loam here lies on the rock.

SANDY HILL, WASHINGTON COUNTY.—The Sandy Hill Quarry Company's quarries are about two miles from the Sandy Hill railroad station, and a half a mile north-east of the canal. The oldest openings are south of the present working site, and several acres have been uncovered and excavated, but only to the depth of one or two beds of stone. The main quarry is on the north-west slope of the hill, and north of the old workings. The *stripping* on the rock is light, usually not more than one to two feet of earth. The uncovered surfaces show deep, parallel joints or seams filled with earth. These joints, which are thus filled with dirt, run to the bottom of the quarry and through the beds. Their course is south  $65^{\circ}$  west, and their dip is nearly vertical to the south-south-east. The other joints are vertical. As these seams are quite close together, the rock is well divided into blocks of convenient size for handling. The beds are from one to seven feet thick, and show a dip of less than  $5^{\circ}$  south. The thickest course, near the bottom is seven feet. The length of the present working face from north-east to south-west is at least a quarter mile; the extreme breadth of the belt quarried over is not less than 100 yards, and the whole depth of quarry beds is 30 feet. The bottom rock is workable stone, and at least 40 feet could be quarried, if the stone



were wanted. In working the quarry, holes of elliptical shape, and four feet deep are put down with a reamer, and then the blocks are split along the line of these holes. The horizontal lifts are made by wedges. The dressing of the large blocks is done on the stone dressing floor at the quarry. A narrow-gauge railway runs through the quarries, with switches to the several parts of the face, and terminates at the canal, a half a mile away. Blocks of 130 cubic feet are conveniently gotten out and shipped. Two stationary engines work the twelve derricks, and a portable boiler runs the steam drills. The stone is of a light-blue color, dense and fine-grained. It is said to weigh 175 pounds per cubic foot. Some of it has a slight ribbon-like appearance, due to the lamination of the beds. The strength of this stone is shown by the report of Prof. Thurston.\* The greater part of the stone is shipped over the line of the canal. The railroad carries a small part only, and is over one mile distant. As the quarry is above the natural drainage, there is no pumping. The natural joints, which divide the rock into large, rectangular blocks, make this location a favorable one for quarrying, and the stone is specially adapted to heavy masonry; very little of it is used for common walls and house work. It is being used in the Arthur-Kill bridge on Staten Island Sound, in the bridge piers at Poughkeepsie; and for the base of the Bennington Monument in Vermont; also for the Croton Aqueduct Gate House, New York. A large force of men is employed the greater part of the year, and the output of the quarry (in cubic yards), probably exceeds that of any other in the State.

These quarries are in the horizon of the Calciferous sand-rock, and the stone is a siliceo-magnesian limestone.

Half a mile north-east of the quarry of the Sandy Hill Company, limestone has been opened in a low ledge, for a length of 150 yards, north-east to south-west, and for a breadth of 30 yards. The quarry face is 10 to 20 feet high, and the covering of earth is from one to three feet. The dip of the bed is  $8^{\circ}$  south-east. One system of seams or joints runs east and west and vertical; a second one at right angles to the first; and another, not so plain, runs south-west. The beds are from one to four feet thick. The stone is hard and brittle, but dresses readily, and the division of the mass of rock by

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\* According to the published report of Prof. Thurston, the crushing strength of this stone, as shown by his tests, ranges from 18,500 to 28,500 pounds per square inch.

these joints is favorable to economical quarrying. The place is worked irregularly.

**GLENS FALLS.**—The Hudson river gorge at Glens Falls affords a good vertical section of the Trenton limestones, and two large quarries are opened in its sides. The quarry of the Morgan Lumber and Lime Company, on the Saratoga county side, or right bank of the stream, has the following order of beds from the surface :

|  |          |
|--|----------|
| 1. Black, slaty rock in thin layers..... | 15 feet. |
| 2. Gray limestone.....                   | 10 feet. |
| 3. Black, thin-bedded limestone.....     | 12 feet. |
| 4. Gray limestone.....                   | 2 feet.  |
| 5. Black <i>marble</i> .....             | 12 feet. |
| 6. Limestone.....                        | 4 feet.  |

The top, slaty rock affords some flagging. The gray stone (2) is used for lime. The thin beds of (3) yield stone for rough work only. It is known locally as "buckwheat" beds. No. 4 of this section is good for cut work. The limestone at the bottom is suitable for heavy masonry, but is not quarried here. The beds dip  $5^{\circ}$  southward. The main set of joints is vertical and has a course of south-south-west.

This company has a mill for sawing the marble. The lime business has, however, taken the place of the *marble*, and the *marble* beds are now mined for lime making.

The quarry of the Glens Falls company is on the north or left bank of the river and below the Falls. Work has been done here for a length of a half a mile, and in places, back at least 100 feet from the river. The vertical succession of beds from the top is as follows :

|   |            |
|---|------------|
| 1. Gray, thin-bedded limestone.....       | } 18 feet. |
| 2. Gray-black, thin-bedded limestone..... |            |
| 3. "Jointa lime" beds (three).....        |            |
| 4. Black <i>marble</i> .....              | 12 feet.   |

The beds dip  $4^{\circ}$  south. The joints run south, or a few degrees west of south, and a second set east and west, and both are vertical. They are generally several feet apart, and of great service in the quarrying of large blocks. The gray crystalline limestone at the top is sold in the rough for common wall work, or is dressed for sills, lintels and for house trimming. It is a good building stone, but the quarrying of these upper beds is subordinate and incidental to the marble

business. The *marble* occurs in two thick beds, and blocks of 100 cubic feet are readily gotten out from them. The mass is nearly black, fine-grained and dense. It is hard and brittle, but is capable of being dressed in any style. It takes a brilliant polish, and the polished surfaces are jet black. For tiling it is particularly well adapted, as it does not wear slippery and it retains its color. For sills, lintels, water-tables and general house trimmings also, it makes a first class material. The mill, with four gangs of saws, is at the west end of the quarry and near the bridge. Tiles, shelves, mantels, sills, lintels, coping-stone, wainscoting, billiard table tops and material for all inside decorative work are cut. The interior trimmings of the Equitable Life Insurance building, New York, is one of the best examples of this *marble*. Its market is all over the country as far as Chicago and New Orleans. And it is said that some of the so-called "imported" black marble comes from these quarries.

As the quarry is in the side of the river bank the drainage is natural. Very little blasting is done, excepting in the top rock. The waste (spalls, etc.) are burned into lime. The quarry is a half a mile from the Delaware & Hudson Canal Co.'s (Glens Falls) railroad and at the side of the canal (Champlain feeder).

WHITEHALL, WASHINGTON COUNTY.—The Arana Marble Company (of Rutland, Vermont) has opened a quarry in the Chazy limestone formation, about half way between Whitehall and Fairhaven, and at the side of the Rutland railway line. The limestone is compact, sub-crystalline, and has a veined appearance. The ledge which has been opened is below the water level and close to the track. It has not as yet been developed into what may be called a marble quarry. At present the limestone of a sidehill outcrop, on the same property, is quarried extensively for flux, which is used at Troy.

CROWN POINT, ESSEX COUNTY.—Blue limestone of the Trenton period is quarried at the side of the New York and Canada railroad, about one mile north of the Crown Point station. The stone is fine-grained and suited for building. It has been used at Port Henry, Plattsburgh, Saratoga and points along the railroad, for curbing and some cut work.

WILLSBOROUGH NECK, ESSEX COUNTY.—The Chazy limestone formation (which underlies this neck or low promontory) has been opened in two quarries. They are on what is known as Lagoneer or



Clarke's Point, and on the east side of the neck. About eighteen acres of land is here, in part covered by a thin soil only, or the solid, glaciated rock makes the surface. The quarry of the Lake Champlain Blue stone Company is opened on the line of strike of the rock, about due west, for a length of 1,000 feet, and at the west side its breadth is 250 feet, or an area estimated at three acres. The greatest depth was 25 feet, all above the lake level. The beds dip  $6^{\circ}$  to  $8^{\circ}$  north,  $10^{\circ}$  east; and they are divided by a set of seams or joints, which run north  $10^{\circ}$  east and by another, which is less regular and persistent, in an east to west direction. The first system is vertical. The beds are from one to six feet thick; and the whole thickness of the workable beds is 16 to 18 feet. The stone is light blue in color, weathering on exposure to a light gray; and, in some of the mass, showing lenticular and roughly parallel-arranged, thin layers of ash-gray in the darker matrix, somewhat like the clay seams of some limestones. There is a dock at the south-east side of the quarry; and the six derricks and engine-house are still in the quarry. The place was worked extensively from 1854 to 1869, by S. W. Clark & Company. Large quantities of the stone went to the capitol at Albany and to the Brooklyn bridge.

S. W. Clark works the quarry about 30 rods west-north-west of the old quarry. The dip and joints or seams and the stone are much like those of the latter. The very regular, vertical joints, the even beds, the absence of any *stripping*, and the convenient location to navigation are the notable advantages of the place.

The Willsborough Neck or "Lake Champlain blue stone" was used in the Reformed church, Swan street, Albany; in the State street Methodist Episcopal church in Troy; in the Brooklyn bridge piers, and in the eastern foundations and sub-basement of the capitol at Albany. From one hundred to three hundred men were employed from 1869 onward for two to three years. At present the force is from six to ten, and the business is ashlar and cut trimmings for buildings, and specially in heavy blocks for bridge and lock work.

PLATTSBURGH, CLINTON COUNTY.—North of Plattsburgh, and in the town of the same name there are several quarries in the Chazy limestone formation which are worked according to the demand for stone. The principal ones are within two miles of the town on the east of the Beekmantown road.

The first one here to be noted is the Pratt quarry, a few rods west

of the same road. It is now owned by Hugh Behan. An area of 500 feet in length, north-west to south-east and half as wide nearly, has been gone over, and the stone removed to a depth of from five to eleven feet. The covering on the rock is nowhere more than one foot thick. The strata dip  $7^{\circ}$  to  $8^{\circ}$  easterly. The rock is divided vertically by one marked, smooth joint plane, which runs south  $65^{\circ}$  east; and by another whose course is north  $15^{\circ}$  east. They occur at intervals of 18 to 20 feet apart, and are very regular. The stone is of a bluish-black color, hard and semi-crystalline. On weathering it fades to a gray shade. But unless well selected it is apt to show clay seams. A vertical section of the strata at the deepest part of the quarry shows: weathered rock, one foot; then the blue limestone in beds, two feet, one foot, two feet, four and a half feet and two feet thick, respectively, making in all a thickness of 11 feet 6 inches. There is very little water, and no pumping is necessary. Some of the stone from the quarry is used for making lime. A fine example of this stone is seen in the Peristrome Presbyterian church building in Plattsburgh.

On the east of the Beekmantown road, and north-east of the Platt quarry, there is an excavation 100 yards x 70 yards, from which a large amount of stone has been taken. At this place the dip of the strata is very gentle eastward. The rock here is divided by a regular joint, which dips  $75^{\circ}$  north  $5^{\circ}$  east, and runs south  $85^{\circ}$  east, and by a second, running north  $15^{\circ}$  east, and nearly vertical. At this quarry the courses or beds are: top, two feet thick, second, two and a half feet, and bottom three feet. It is bluish-black, excepting on weathered surfaces, which are gray. This quarry belongs to Mrs. McCready, and is worked occasionally by Peter Lezotte, of Plattsburgh. The stone has a good reputation for heavy work, for which it is admirably suited. It has been used by the D. & H. Canal Company in some of their bridge work on the N. Y. & Canada Railroad line.

One-fourth of a mile north, and on the same side of the road, is what is known as the Fitzpatrick quarry, a small opening, which is worked a part of the year only. The greater part of the product is used as furnace flux, but some of the stone is gray and of a crystalline structure, and when polished merits the name of marble.

North of the latter is Morrison's quarry, in a gray limestone. It furnished most of the stone for the St. John's Roman Catholic church in Plattsburgh, and a part of that used in the Peristrome Presbyterian church.

South of Plattsburgh, three and a half miles, Peter Lezotte quarries a gray limestone on lands of the Burlington Manufacturing Company. There are two openings between the D. & H. R. R. and the lake shore road. The northern opening is 160 yards long, from north to south, and 30 yards wide. The depth of stone does not exceed 15 feet. The beds dip a few degrees easterly. One system of joints runs south  $10^{\circ}$  east, vertically, and is open. Another, not so plain, is nearly at right angles to the first set. There is one derrick at this quarry. The southern opening has the rock covered by drift earth to a depth of one to three feet. The upper surface is glaciated and solid. The stone is fine-crystalline in texture, and gray to red in color. The dip here is a few degrees to the eastward. The joints are vertical and at convenient distances apart for getting out large blocks. The beds are from three to six feet thick. The depth of this opening is 15 feet. Its approximate dimensions are 80 x 30 feet. The stone is considered superior to that on the north, being more solid. A derrick, a steam pump and one channelling machine are in use. Blocks weighing 17 tons have been taken out of this quarry, and shipped. It is all carted by teams to the lake shore, one mile south-east of the quarry. The principal markets are Plattsburgh and Burlington, Vermont. The first opening was made about fifteen years ago. This stone dresses easily and takes a high polish, and is known in the market as "Lepanto marble."

HOFFMAN'S FERRY, SCHENECTADY COUNTY.—There are two quarries in the town of Rotterdam, Schenectady county, near Pattersonville station, which are worked at intervals. They are opened in the limestone on the hill, 200 feet above the Mohawk river, and a half a mile south of Pattersonville station (West Shore railroad) and the Erie canal. That of James Walker was opened a few years ago, when the New York, West Shore and Buffalo railroad was built. The face has a south  $55^{\circ}$  east course and a length of 150 yards, and has been worked back 75 feet from north to south. There is from 1 to 4 feet of gravelly, drift earth on the stone. Then the beds which are quarried range from 4 to 18 inches in thickness, and the total thickness of quarry beds is from ten to fifteen feet. At the west end there are two beds, each two feet thick, of gray, semi-crystalline limestone. The dip is to the south-south-east at a small angle. The main joint system runs vertically south-east. The drainage is natural. One horse-power derrick in the quarry serves for loading on wagons,



on which stone is carted to the canal or railroad. The stone is sold for rough wall work, and is cut for house trimmings.

Mrs. Moore's quarry adjoins that of Walker on the east, and with it makes really one continuous opening. The excavation has gone over an area of 100 yards by 50 yards, and the face of the quarry runs a south  $20^{\circ}$  east course. It is 10 to 15 feet deep. The dip is  $3^{\circ}$  south-south-east. One system of joints runs south  $45^{\circ}$  east and a second one, north  $20^{\circ}$  east, vertically. Here also the top strata are thin, and the thick beds are at the bottom. This quarry has not been in operation for several years past.

Both of these quarries are in the Trenton limestone.

AMSTERDAM, MONTGOMERY COUNTY.—The building stone quarries at this place are one mile from the N. Y. C. railroad station and near the Chuctanunda creek, and from 180 to 250 feet above the Mohawk. The quarry beds crop out in the sides of the creek valley. Ascending northward, the first quarry is that of James Shanahan, which is on the eastern side of the creek, and about 200 yards north of the paper mill. The working face is 200 feet long from east to west, and has in it a thickness of 8 to 12 feet of quarry beds, above which there is drift earth up to 10 feet thick. The beds are from 1 to 3 feet thick, and they dip very slightly to the west. The stone is blue and sub-crystalline. The quarry has one derrick and there is natural drainage. On the west side of the stream, Thos. J. Donlon quarries limestone on the Vanderveer farm. This place was opened first nine years ago. The working face has a length of 500 feet, parallel nearly to the creek, and is 15 to 20 feet in height. The joints run, vertically, north and south and east and west. The beds are from 2 inches up to 2 feet thick; and the bedding surfaces are rather rough and uneven. The stone is a blue limestone, of Trenton epoch. The product goes mainly for common masonry, as foundation walls. Another quarry has been opened north of Vanderveer's for limestone to be used in lime making.

The quarry of D. C. & N. Hewitt is on the left side of the Chuctanunda creek and east of the Rock City road. At the south opening, which was made many years ago, the rock is a dense, blue limestone, like that of Shanahan's quarry. It is the largest and deepest excavation here. The new quarries are about 20 rods northward and on the same side of the road. At this place a large area has been worked over, since two beds only are raised.

The vertical section of the quarries, as stated by Mr. Hewitt, is as follows :

- |                                |               |
|--------------------------------|---------------|
| 1. Rough limestone .....       | 1 to 4 feet.  |
| 2. Gray stone .....            | 6 inches.     |
| 3. Gray limestone .....        | 12 inches.    |
| 4. Shelly stone .....          | 16-20 inches. |
| 5. Shelly stone (boring) ..... | 6 to 8 feet.  |
| 6. Blue limestone at bottom.   |               |

The top beds are used for lime making. The bed (2) is sold for common building stone, sidewalks, etc. The next bed is the valuable one of the quarry, and is cut into dimension stone, for platforms, steps, sills, lintels and house trimmings. The "shelly stone," near the bottom, is mixed calcareous and argillaceous layers, but is smooth on bed surfaces and breaks *true*. It is used as a common building stone. The blue limestone at the bottom is the same bed which is opened for a thickness of 14 to 18 feet in the old, or south quarry. At the latter the beds are 1 to 3 feet thick. Under this blue limestone there is the livery-looking, black to yellow stone, supposed to be a *cement-rock*. It is 8 feet thick. The dip of the beds is undulating in the quarry ; on the west of the road it is a few degrees west. The joints are tight, and in places the stone is "seam-bound." Drainage is natural. Two small derricks answer for loading and moving stone. These quarries are in the Birdseye and Trenton limestone formations.

A large amount of stone used in the foundation of the capitol at Albany was obtained from Amsterdam, and from Shanahan's quarry. Albany, Cohoes and Troy are chief markets outside of Amsterdam.

For home use a great deal of stone is quarried here on the sites for buildings and the excavations for cellars often yield stone enough for the walls.

**TRIBES HILL, MONTGOMERY COUNTY.**—Henry Hurst & Sons. The eastern end of this quarry is less than 100 feet west of the Tribes Hill station on the N. Y. C. R. R., and between the railroad and the Mohawk river. Its working face looks south-east and trends in a south-west course, nearly 50 rods. The vertical section in the eastern part of the quarry includes the following members :

- |  |          |
|--|----------|
| 1. Soil covering the rock.                       |          |
| 2. Blue, thin-bedded limestone .....             | 10 feet. |
| 3. Gray, crystalline limestone .....             | 6½ feet. |
| 4. Gray limestone mixed with blue limestone .... | 7 feet.  |
| 5. Blue limestone at bottom.                     |          |

The top beds range in thickness from a few inches to a foot. The gray limestone (3) is sometimes one solid bed, but in places it is divided by a bedding plane, and an upper layer, 20 inches thick, can be lifted off. The strata dip gently toward the north-west. There is at irregular intervals, and generally from 10 to 20 feet apart, a north-west dipping system of joints whose faces resemble those of slickensides. It does not penetrate deeply into the gray stone. The top, blue, limestone, is not dressed, but is sold for common walls or rubble work. It is a good stone for lime making. The gray limestone is fine-crystalline to sub-crystalline, and of a light-gray shade of color, when fine-pointed or bush-hammered. Polished surfaces looks almost like black marble. It is mostly worked into cut stone for house trimmings. For rock-ashlar also it looks well. The blue limestone at the bottom is occasionally quarried and cut for bridge work. But the product of the quarry goes mainly into house work. The drainage is to the river, and no pumping is necessary, as at the south-west end of the opening the bottom rock is on a level with the ordinary water level. Two derricks are in use for hoisting and loading the stone. Stone from this quarry may be seen in the churches in Amsterdam.

James Shanahan's quarry is east-north-east of the Tribes Hill railroad station, about 60 rods. It is on the north side of the Central railroad track, and has a face of 500 feet from east to west, and from 25 feet in height at the east end to a height of 50 feet near the west end. The lowest excavation is 15 feet below the railroad grade and at least 10 feet above the river. The top beds are thin and siliceous in part, and there is some dark-blue, thin-bedded limestone in the upper part. The lower beds are thick and a gray, sub-crystalline limestone. And there is a thickness of 25 feet of beds, from two to four feet thick. The dip is approximately  $5^{\circ}$  south  $65^{\circ}$  west. One main system of joints, vertical, runs north  $80^{\circ}$  west, and a second system, less well marked runs at right angles to it. There are four derricks, and a track into the quarry. The drainage is natural. The product was largely for heavy masonry. As the stone is rather hard it does not dress easily. The quarry has been idle for several years.

At Rocky Hill, three-eighths of a mile north-east of the village, quarries have been worked on lands of Victor Putnam and Henry Hurst. The stone in the upper beds is black and thin-bedded. The dip is gentle to south-west and the excavations are shallow, and in the



top of the south-facing escarpment, and 175 feet above the railroad station. These quarries have been worked at intervals for flag-stone and stone for curbing streets.

CANAJOHARIE, MONTGOMERY COUNTY.—In and near Canajoharie there are three quarries. The oldest of them, that of A. C. & C. H. Shaper, is in the western part of the town, and about 40 rods from the Erie canal and the N. Y., West Shore and Buffalo railroad. The quarry face has a length, approximately, of 1,000 feet, from north-east to south-west, and looks north-west. The quarrying work has moved south-east and south-west, and has reached in places the limits, on account of buildings in the way. The dip of the beds is nearly  $10^{\circ}$  in places, and to the south-east. A very regular system of joints runs with the strike, in a south-west direction, and at convenient intervals for working. There are no south-east running joints, or seams, except wide spaces apart. The bedding is true and regular, and the vertical section, as given by Mr. Shaper, is :

|                                 |             |
|---------------------------------|-------------|
| “ 1. Sand.....                  | 30 inches.  |
| 2. Gray limestone.....          | 12 inches.  |
| 3. Sand.....                    | 30 inches.  |
| 4. Gray and blue limestone..... | 12 inches.  |
| 5. Gray limestone.....          | 12 inches.  |
| 6. Gray limestone.....          | 24 inches.  |
| 7. Gray limestone.....          | 12 inches.  |
| 8. Sand.....                    | 30 inches.  |
| 9. Sand.....                    | 8 inches.   |
| 10. Blue limestone.....         | 15 inches.  |
| 11. Blue limestone.....         | 12 inches.  |
| 12. Blue limestone.....         | 4 inches.   |
| 13. Blue limestone.....         | 3 inches.   |
| 14. Sand.....                   | 10 inches.  |
| 15. Sand.....                   | 10 inches.  |
| 16. Blue limestone.....         | 2 inches.   |
| 17. Gray limestone.....         | 8 inches.   |
| 18. Blue and sand.....          | 20 inches.  |
| 19. Blue lime and sand.....     | 30 inches.  |
| 20. Hard sand block.....        | 36 inches.  |
| 21. Blue sandstone.....         | 12 inches.  |
| 22. Blue lime.....              | 20 inches.  |
| 23. Gray lime.....              | 18 inches.” |

This section shows the thickness of the several strata and their alternations and succession. The chief varieties are blue and gray stone. All of it is hard, but it dresses well and splits *true*. The gray limestone is sub-crystalline. Some of the bottom, sand beds are a little calcareous, and they weather brownish-colored on surface. There are four derricks in the quarry, and steam power is used to work a steam drill and gadding machines. The stone are carted to railroads and canal. The quarry is at least 60 feet above the canal. The stone is used for engine beds, monumental bases, sewer blocks, house trimmings and canal lock construction. Stone from this quarry has been put into all of the churches in Fort Plain and Canajoharie, and in large mill buildings in Utica. Some of it was used in the Brooklyn bridge foundation. It was opened in 1852.

Samuel Morell's quarry is in the eastern part of the town, and 40 rods south of the West Shore railroad. It was opened first in 1883, and reopened in 1885. The covering on the rock consists of soil only. The upper beds are mostly thin, from four inches thick upwards, and a blue limestone; and at about 14 feet down there is a 20-inch bed. Then comes a bed five feet thick, of blue limestone. The following vertical section gives the succession of the strata :

1. Soil covering the rock.
2. Blue limestone, in beds from 4 inches to  
20 inches thick (at bottom) ..... 14 feet.
3. Blue limestone ..... 5 feet.
4. " Sand course," siliceous limestone ... 2 feet 2 inches.
5. Limestone ..... 1 foot 6 inches.
6. Limestone ..... 1 foot 6 inches.
7. Limestone ..... 1 foot 8 inches.
8. Gray limestone at bottom.

The dip is to the south-west and at an angle of about 5°. Well-marked joints, vertical, run east to west and north to south, and at distances apart so as to form blocks of good size for heavy work. The working face of the quarry is toward the west and the quarrying moves eastward and to north-east, or up the plane of dip. There is little water, excepting at the bottom. Two derricks, worked by horse power, are in use. Little powder is needed in blasting. The stone dresses well and it is now used largely in face blocks, for the Erie canal locks, three miles east of Canajoharie. This quarry is worked in the winter whenever the demand calls for stone. The

small proportion of waste rock and the natural facilities for economical working out heavy stone are advantages of this quarry.

**QUARRY OF RICHMOND & BULLOCK.**—This quarry is in the north face of a natural escarpment, one mile east of Canajoharie, and at the side of the canal and the West Shore railroad. It was opened the present season (1887). The bluff is nearly vertical for 70 feet, up from the Mohawk flats, and then it slopes steeply for 30 feet to the top. The upper part of the bluff is now being cleared off to the rock, and preparations are being made to quarry the beds from near the top, down for a distance of 25 to 30 feet, and to a level which is 60 feet above the valley. These top courses of stone are thin and are blue limestone, which dips gently south-west. The main system of joints runs vertically, in a south-west direction at intervals of 10 to 12 feet. One derrick is placed on the upper level and a second one stands at the side of the railroad track. An iron-shod chute allows the stone to be sent down to the track level. Near the foot of the bluff there is a ledge of fine-grained, reddish-colored rock, which is hard, and capable of polish, and which appears to be adapted to ornamental work. As it is siliceous it will resist weathering better than the limestone.

The Canajoharie quarries are in the Calciferous formation, and that of Richmond & Bullock is near the bottom and lower, geologically than the quarries in the town.

**FORT PLAIN, MONTGOMERY COUNTY.**—The Birdseye limestone was formerly quarried quite extensively at this place, for local market. A small quarry at the north side of the New York Central railroad track, and about 100 yards east of the station, is the only one now in operation. The beds are thin and are dipping gently, south-east.

**PALATINE BRIDGE, MONTGOMERY COUNTY.**—There are two quarries in the limestone at Palatine Bridge, on the north side of the Mohawk river. The westernmost quarry is that of S. L. & A. B. Frey. It is north of the Central railroad tracks about 20 rods, and little further from the Frey mansion. It was opened three years ago. Nearly a half an acre of territory has been worked over in the excavation. The covering of boulder earth on the stone is from a thin soil layer to six feet in thickness. The stone is a blue limestone, but there is much variation from bed to bed, and some of the beds are quite sandy. At the bottom there is a thick bed of gray limestone, which



does well for cut work. The blue stone is put into heavy masonry and common, wall work. The dip of the strata is a few degrees and to south-west; and the vertical joints run in the same direction. The drainage is natural; and the bottom of the quarry is 20 feet above the railroad track. Three derricks are in use. The stone is carted by team to the canal or to the Palatine Bridge station; and a large amount has been quarried here during the past season. The stone of this quarry may be seen in the East avenue Presbyterian church of Schenectady.

Wm. Johnson of Palatine Bridge opened a quarry on his lands in the north-western part of the village the past season.

These quarries are in the Calciferous formation.

**LITTLE FALLS, HERKIMER COUNTY.**—The Calciferous sandrock is quarried at several places in and near this town, in the bluff to the north. Three of the quarries are near one another, north-east of the town and a half a mile from the Central railroad station. At the most western quarry the face is 100 feet long and 20 to 30 feet high. The beds are nearly horizontal and from one to two feet thick. The stone is light-gray shade and is fine-grained. It is used for common wall work.

The next quarry to the east is 300 feet long, from east to west, and is 55 feet high, and has in it 30 beds. One main system of joints is vertical and strikes north-west. The stone has a bluish-gray shade of color, weathering light-gray on exposed edges. It is fine-grained. At the top the beds are somewhat decomposed, and the stone is rotten, and of little value for building purposes. The lower beds are  $1\frac{1}{2}$  to 2 feet thick.

The next quarry, to the east 20 rods, has a length of 300 to 350 feet and a maximum height of 40 feet. At this quarry also, the top strata are much weathered and disintegrated, and of no value as building stone. It does not appear to have been worked in some time. The stone resembles closely that of the quarry next it on the west. Both of these old quarries are in the rear of the street and 200 feet from it. The stone from them is used for cellar walls and retaining walls and for street curbing. The gneissic rock outcrops are to the south, less than 300 feet away, but on lower ground.

One and a half miles north-north-west of Little Falls, on the Wilcox property, the Trenton limestone is quarried by Haulon Brothers. The locality is 300 to 400 feet above the Mohawk valley and a quarter of a mile east of the school house. A thin layer of soil

lies upon the rock, which at the top is thin-bedded and highly fossiliferous. This thin-bedded stone is thrown out on the dump as waste. The beds which are quarried, are from four inches to three feet thick, and consist of the Birdseye limestone. They are nearly horizontal. The joints run regularly in a north and south direction, and east and west, and vertically. The total thickness of the quarry beds is 18 feet. From the bottom of the quarry the limestone has been found to run down 10 feet to a sandstone. The stone is largely sold for curbing, and some for flagging, and a little for common wall work. The top rock is either given away for walls or is sold at rate of one dollar a ton in the town. There is little water excepting at the bottom, and no pumping is necessary.

NEWPORT, HERKIMER COUNTY.\*—There are three quarries in the limestone worked in this town. They are owned by Waldo Sherman, Wm. Reynolds and John O'Connor. All have been opened within three years. They are from one to one and a half miles from railroad.

HOLLAND PATENT, ONEIDA COUNTY.—Martin Olin and J. G. Hill-edge have quarries in the Trenton limestone formation at this place.

PROSPECT, ONEIDA COUNTY.—There are four quarries opened and worked on the West Canada Creek, between Prospect and Trenton Falls.

The first quarry south of Prospect is that of Evan S. Thomas, on the right bank or Oneida county side of the stream. The rock is covered by soil and subsoil only. The strata are nearly horizontal, and range from 4 to 16 inches in thickness. Seams, or joints, traverse the rock in a nearly north to south course. The quarry beds have a total thickness of 20 feet. The bottom of the quarry is perhaps 50 feet above the creek, and the drainage is that way; and the waste and *stripping* are thrown off the edge of the bluff into the gorge. The stone is gray, sub-crystalline, and is rather easily dressed. The output is carted to the R. W. & O. railroad station, one and a half miles away and shipped to Utica, Rome and other points. Stone are in the U. S. Government building at Utica; R. C. church buildings at Little Falls and Sandy Hill; M. E. church at Herkimer, and in several church buildings at Norwich. The quarry was opened in 1852.

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\* The locality was not visited.

Across the creek and on the Herkimer county side, Edward Callahan quarries limestone. The covering, strata and situation are quite like those of Thomas's quarry. The vertical section includes the following members :

|   |              |
|---|--------------|
| 1. Earth, covering stone.....                                       | 1 to 3 feet. |
| 2. Thin and irregularly bedded, dark-blue limestone .....           | 7 to 8 feet. |
| 3. Quarry beds (12 in., 14 in. and 5 in.)....                       | 2½ feet.     |
| 4. Calcareous shale ("shelly bed").....                             | 1 foot.      |
| 5. Quarry beds (10 in., 6 in. and 8 in.)....                        | 2 feet.      |
| 6. Slaty rock ("big scale").....                                    | 2 feet.      |
| 7. Quarry beds (6 in., 6 in., 5 in., 5 in., 10 in. and 11 in.)..... | 3½ feet.     |

The strata dip at a small angle northward. A close seam or joint, nearly vertical, runs north to south, and another, but open, courses in a general east and west direction. These seams assist in quarrying, and a little powder is used to break down top rock only. By means of plug and feather wedges the blocks are split apart, and the thickness determines the use. Platforms, flagging, lintels, sills, and water tables are cut. In some of the thicker beds there are shaly laminae, or parts, which on weathering, disfigure the stone by their dirty yellow color in the darker-colored mass. The distance to railroad is about one and three-quarter miles. Utica is the principal market, and Mr. Callahan has a yard in that city.

The quarry of George & Griffith (of Utica), is on lands of Mrs. John S. Clark, one mile south of the last noted, and on the east or left bank of the creek. The covering of earth is here also thin, and the beds are nearly horizontal, and eight courses or beds are worked. They are from four to sixteen inches thick. The stone is shipped to Utica as the main market. This quarry was opened in 1860.

The quarry of H. & L. N. Jones is on the west or right bank of the creek, one mile south of Prospect village. It has been opened for twenty-five years, and worked by the present firm for nine years. The vertical section here is as follows :

|                                       |         |
|---------------------------------------|---------|
| 1. Earth .....                        | 2 feet. |
| 2. Irregularly bedded limestone ..... | 3 feet. |
| 3. Quarry beds (five).....            | 6 feet. |
| 4. Shaly limestone.....               | 4 feet. |

The bedding at this quarry runs unevenly, and the top strata cannot be followed throughout from end to end. The beds lie nearly



horizontal, probably dipping very slightly, southward. An open seam or joint, somewhat irregular, runs across this quarry and across the creek to the opposite quarry in a course north  $83^{\circ}$  east. These seams are wide apart. A set of tight seams or joints, nearly vertical, runs south  $17^{\circ}$  west; and these latter are of great service in the excavation of the stone. The average thickness of the quarry beds is from 10 to 12 inches, but at the south end there is one that is 2 feet thick. Northward the same bed splits into two layers. The top stone is sold or given away for foundation and common walls. The quarry beds are worked up into cut stone, and mostly for house trimmings, but a part is used for monumental purposes. The principal market is Utica, and recently some of this stone has been used as rock-ashlar for building fronts in that city.

On account of the light covering of earth on the rock; the ease with which the waste, cap-rock and dirt is removed; the natural drainage and the convenient thickness of the quarry beds for cut stone, these Prospect quarries are worked with economy and profit. The stone is carted by teams to Prospect station, from one to two miles distant from the quarries. About 20 men are employed in the four quarries. The stone is known as the Trenton gray limestone. It has been employed very largely in Utica for ax-hammered, bush-hammered and fine-pointed house trimmings, and also for platforms and curbing. A single objection to it is in its fading on long exposure to the atmosphere.

**TALCOTTVILLE, LEWIS COUNTY.**—Limestone was formerly quarried to a considerable extent near Talcottville, on the Sugar river. There is said to be a fine exposure of rock along the stream and of excellent stone for heavy masonry. The locality was not visited.

Other quarries in blue limestone are in the same town of Leyden. The strata are thick, and are suited for heavy work. And stone has been quarried there in the past year for canal lock construction.

**LOWVILLE, LEWIS COUNTY.**—Two quarries are here opened in the blue (Trenton and Birdseye) limestone.

Hiram Gowdy's quarry is a few rods east of the railroad and a quarter of a mile south of the station. The face, as worked, is about 250 feet long from north-east to south-west, and it is 10 feet high. The stone is covered by soil only. There are three beds, which are two to three feet thick, and they lie nearly horizontal. The mass is traversed by one vertical system of joints, which runs east-north-east,

and by a second system which is more irregular. The stone is dark-blue, almost black, hard and dense. Dressed surfaces do not show the sharp contrast with the natural fracture surface like the Prospect stone. It is suited to heavy masonry; and it has been used in the new bridge of the R., W. & O. R. R., over the Central tracks at Utica. The quarry is above the natural drainage into the creek. One derrick does the hoisting.

Luman Carter's quarry is on the right bank of the creek and a half a mile south-east of the railroad station. The face of the quarry is nearly parallel to the creek, and about 400 feet long and 80 feet in height. The stratification is nearly horizontal or with a slight dip to the north-west. The seams or joints run vertically east and west, and about twelve feet apart; others are less regular. These seams help in the extraction of large blocks. The top strata are of a light-blue stone, and the surface, when uncovered, shows beautiful glacial lines in a north-west and south-east direction. The upper beds are heavy and answer for bridge work; under them the thinner courses, or beds, work up readily into dimension stone for house work. The rough stone of the more irregularly bedded part of the quarry is worked into rubble or common foundation walls. Lowville is the principal market. But the heavier stone go into bridge piers and heavy masonry in all parts of the county, and some to Utica. The beds are all above the creek, and there is no pumping needed.

The Lowville stone is used for bases in cemetery work. It looks well when fine-pointed, but it is not so easily dressed as the Prospect stone, and is much darker in shade, both dressed and in the rough.

**THREE-MILE BAY, JEFFERSON COUNTY.**—At Three-Mile Bay, the limestone outcrops are so near the surface that much stone is obtained at many places for local needs. The only quarry, which is worked steadily, is that of John J. Barron, one mile south of the village, and a half a mile from the railroad station. It is practically on the lake shore, as the dock is only 100 yards or so west of the quarry. The depth of water off the dock at this point is 15 feet. The place was first opened nearly forty years ago, and a large quantity of cut stone for heavy work was gotten out. It was reopened fifteen years ago. The excavation has a length of 200 yards from north to south, and a breadth, back, of 40 yards. The beds dip about  $7^{\circ}$  to the east. The main seams or joints are dirt filled, and run in a south-westerly course, irregularly, and 5 to 10 feet apart. The surface stone is thrown off as waste, although good for lime. The beds are: first, the top, 28

inches thick ; then, one 18 inches thick ; a third one 6 inches thick ; and the bottom, 7 inches. These two lower beds alone are worked for cut and dimension stone, and the heavy beds at the top go into flagging material. The stone is sold at the quarry at 25 to 40 cents per square foot, according to size. The lower bed is cut for coping 10 inch and 7 inch, and is fine-pointed and sells at about \$1 a running foot. The product of the quarry, as now worked, is largely put into the market for house-trimmings. A part of it, however, is used for cemetery work.

Nearer the village and near the water the top beds are well exposed on the surface ; and Barron has opened the locality and worked a 10-inch layer, which appears to be equivalent to the 6-inch and 7-inch layers at the southern quarry. A few rods north-east of Barron's house there is an abandoned quarry, where the beds are thick, and the stone strong and solid ; and it was once worked for bridge stone. The drainage at these openings is natural, and there is no machinery employed. The markets for the stone are Watertown and points on the lake shore.

CHAUMONT, JEFFERSON COUNTY.—The following quarries are opened in and near the village of Chaumont :

Copley's quarry, worked for lime ; the quarry of Belden, Johnson & Company, of Syracuse, on the shore of the lake ; the quarry of Adams Brothers ; the quarries of Du Fort & Son, on land of H. Copley.

The quarry of Belden, Johnson & Company, on the bay, has a working face of 500 feet in length from north-east to south-west, and a breadth of 100 feet, at least, at the eastern end. The main joints run, vertically, south  $82^{\circ}$  west and north  $25^{\circ}$  west. The strata dip slightly, westward. The upper beds of rock are somewhat irregular, and, in part only, available for building stone. It answers, however, for common walls, and is 8 to 9 feet thick. Under it there are four feet of thick beds for cutting and dressing. Next below, follows a thin and irregular layer, a foot thick ; then, the gray, sub-crystalline limestone, in beds, 6, 6, 12 and 8 inches thick, or in all, 2 feet 8 inches. At the west end the dip carries the beds below the lake level, necessitating some pumping. This quarry is worked at intervals by Adams Brothers.

The main quarry of Adams Brothers is on the bay shore, in the village. The quarry face is at least 600 feet long (from east to west),



and is 17 feet high ; and the order of the strata, from the top is as follows :

1. Dark-blue limestone..... 8 to 10 feet.
2. Gray limestone (32-inch layer) ..... 2 feet 8 inches.
3. Gray limestone (16-inch layer)..... 1 foot 4 inches.
4. Gray limestone..... 4 feet.
5. Black limestone, ten feet above the  
water level of lake.

The seams or joints in this quarry are remarkable for their regularity, and they are a great help in quarrying. One set or system runs south  $80^{\circ}$  west, and dips  $80^{\circ}$  to  $85^{\circ}$  southward ; a second system runs south  $10^{\circ}$  west, vertically. They are from five to fifteen feet apart. The dark-blue stone of the upper part is burned into lime, at the quarry kilns. The gray stone of the 32-inch and 16-inch courses or beds, are dressed for lock-facing stone, or are cut for monumental work. The gray limestone of the bottom (4, of section) is cut into sills, lintels, water tables, etc., for house trimmings. This quarry has been opened four years. An example in construction, of this stone, is seen in the Protestant Episcopal church building in Watertown. The quarry is within a half a mile of the R. W. & O. R. R. station.

South of the village, and on the east side of the little bay, are the quarries of Davis, and Du Fort & Son. The Davis quarry is about a quarter of a mile from the village. Blue limestone is seen at the top, then the 32-inch bed and the 16 inch bed, and under them the gray limestone. An area of 600x200 feet is here opened and worked over. This quarry is run at intervals.

DU FORT & SON'S QUARRY is south of the last named, and a half a mile south of the village, and three-quarters of a mile from the railroad station. It is on the shore of the lake ; and at the dock near the quarry there is a depth of 12 feet of water. The several beds are shown by the following sections :

1. Blue limestone..... 3 feet.
2. Gray limestone (32 in. layer) ..... 32 inches.
3. Gray limestone (16 in. layer) ..... 16 inches.
4. Gray limestone..... 10 inches.
5. Gray limestone ..... 8 inches.
6. Gray limestone ..... 6 inches.
7. Black limestone..... 18 inches.
8. *Shelly* beds, at bottom.

The dip of the beds is very slightly west, as shown by their passing below the level of the water 200 yards west of the quarry. The main joint system runs south  $75^{\circ}$  to  $80^{\circ}$  west, but is not so open as that in the quarry of Adams Brothers. There are two derricks for hoisting stone. The drainage is natural, into the lake. Powder is used for blasting off the top, blue stone, which is thrown away. The 32-inch and 16-inch courses are now quarried for lock construction on the Erie canal. The 10-inch layer is worked into sills, lintels, etc., for house trimmings, and the lower beds are used for flagging. The stone from this quarry can be seen in H. Copley's office in the village. At the present time the product is largely used for Erie canal lock construction.

These Chaumont quarries are, geologically viewed, in the Black river and Trenton limestone. The stone of the thick courses is strong and well adapted to heavy wall work. And a great quantity has been sold for canal and bridge construction. It sells at \$9 to \$13 per cubic yard. The gray stone for house trimmings brings 50 to 60 cents per square foot. About forty men are employed in the several quarries, and the work continues all the year or whenever weather permits. As they are all convenient to lake and rail the markets are reached easily and cheaply.

Limestone is quarried near Brownville at the side of the Cape Vincent Branch railroad, occasionally, and for local use.

At Watertown the limestone is finely exposed in the gorge of the Black river. The strata dip at a small angle westerly. The 32-inch and 16-inch beds of the Chaumont quarries are thinner here. The gray stone underlies them. Up the stream and easterly the dark-colored, knotty limestone is in force.

OGDENSBURG, ST. LAWRENCE COUNTY.—Much limestone has been used in building in this town, and the larger part has been obtained from local quarries, in the Chazy limestone formation. The elegant town hall and St. John's P. E. church are substantial and beautiful examples of the stone, which is found in the valley of the river, in the town. The quarry-site is built over, in part, by the Hub factory. The quarry, which is now worked for local supply, is on the Oswegatchie river, about two miles south of the town.

NORWOOD, ST. LAWRENCE COUNTY.—Robert Murray has a quarry in the town of Norfolk, one and a half miles from Norwood station of the O. & L. C. R. R. line. It is in the blue limestone. The beds

are from five to eighteen inches thick. The stone is dark-blue and compact. It has been used for buildings ; and the following are structures in which it can be seen : Presbyterian churches at Malone, Waddington and Canton ; Roman Catholic church at Hogansburg ; and St. Lawrence county court house, and clerk's office, at Canton.

SCHOHARIE, SCHOHARIE COUNTY.—East of the village of Schoharie, limestones of the Lower Helderberg and Water-lime groups afford excellent building material, and some which is suitable for monumental or decorative work. The quarries are small and are not worked, except when stone is wanted for home use. The black, tentaculite limestone is notable for its compact texture and its capacity to take a high polish.\* It is not opened as a marble. Z. J. Brown, of Schoharie Valley, has used some of it for cemetery work.

A good example of the enduring quality of the blue limestones of the Lower Helderberg group, as they occur in the Schoharie valley, is the old Reformed Dutch church and stone fort (now State property), one mile north of the village of Schoharie Valley. Although built in 1766, the walls are still firm and the stone are not faded nor weathered even on the sharp edges and corners of the blocks.

HOWE'S CAVE, SCHOHARIE COUNTY.—Two quarries have been worked in former years for both building stone and for the hydraulic limestone. The former overlies the latter in the face of the escarpment, on the west side of the valley. The upper beds are known as the "gray stone," and are 15 to 20 feet thick. This gray limestone checks and does not polish, and is best suited for heavy masonry. The tentaculite, or blue limestone under it, is equally hard and solid, and dresses well under the hammer. It is a good building stone. Some shaly beds are interstratified with the more solid and firm stone, and hence there is some waste. The stone quarries are above the cement-rock mines or quarries. They have been idle during the past year

COBLESKILL, SCHOHARIE COUNTY.—Wm. Reilly's quarry is a half a mile north-west of Cobleskill, and in the Upper Helderberg limestone formation. It was opened about 25 years ago. The quarry is 200 feet square. There are 30 feet of workable beds or courses, overlain by *stripping*, seven to eight feet thick, and ranging from five inches to two feet thick. The dip is only about 2° south-

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\* The beautiful black of this limestone, or black marble, in the State Museum suggests its use, and the desirability of further exploration to test the locality.



ward. The seams or joints are south  $10^{\circ}$  west, vertical, and a second set at right angles to the first, and also vertical, but not as regular or uniform. At the bottom there is a thin-bedded, blue limestone, and under that a water-lime rock. Large-sized blocks are readily obtained. Both gray and blue limestones are found, but the greater part is gray and sub-crystalline in texture. It is not as hard as the blue stone, and is more readily dressed. Stone are sold to Albany, Binghamton, and more in Cobleskill. The Methodist Episcopal church in Amsterdam; the German Methodist church, Clinton and Alexander streets, and the R. C. church in Central avenue, Albany, are of this stone.

SHARON SPRINGS, SCHOHARIE COUNTY.—There are two limestone quarries at Sharon. That of C. T. Smith is at the upper end of the village, and at the north side of the street. It is opened in a side-hill. The strata dip at a small angle to southeast; very regular joints run north-east and south-west, and a less persistent set at right angles to the first. The bedding is well marked and regular. The stone is compact and hard, but is said to dress well. It has been used in structures in the village (houses and the Protestant Episcopal church) and for house trimmings. The thin beds answer fairly for flagging and crosswalk stone. The formation is Lower Helderberg limestone.

Another quarry in the place is that belonging to Mrs. Daniel Norton. Francis C. Mallett and Mrs. Jefferson Smith also own small quarries in the vicinity. They all do a local business.

CHERRY VALLEY, OTSEGO COUNTY.—For the local use the Onondaga limestone ledges, which crop out north of the village, furnish an excellent stone. There is no regular quarry, although the amount of stone construction in the place is comparatively large. The stone is light-blue in color, and in thin beds. It dresses well. The Presbyterian church, the Belcher House and other buildings show it to advantage.

SPRINGFIELD CENTRE, OTSEGO COUNTY.—The Onondaga limestone has been opened and quarried to some extent in the McCabe quarry, one mile north of Springfield Centre, and near the Herkimer county line. It was opened in 1869. The beds dip  $3^{\circ}$  to  $4^{\circ}$  south  $35^{\circ}$  west. They range from one to two feet thick. Blocks of large size are readily obtained. The stone was used in building the house of Edward Clark; in the Otsego county jail; and in the Fenimore House, in Cooperstown.

Another quarry in limestone in the same town is at East Springfield, on the road to Cherry Valley.

**PERRYVILLE, MADISON COUNTY.**—The Onondaga gray limestone is well exposed in the creek gorge at Perryville; and it was first opened for building stone, more than 60 years ago, at the time of the Erie canal construction. There are now three quarries in the place, which are worked to some extent. They belong to the E. C. & N. R. R. Company, O. F. Britt, and the J. T. Smith estate.

**ORISKANY FALLS, ONEIDA COUNTY.**—M. Juhl quarries limestone for building and for furnace flux about a half a mile from the N. Y., O. & W. railroad station, at this place. A great face of stone is opened and is reached by a switch from main line into the quarry. The covering of earth is 2 feet thick. Then follow: the blue limestone, 10 to 30 feet thick; and next, in beds ranging from four inches to two and a half feet thick, blue limestone suited to building. The quarry was first opened at the time of the Chenango canal construction.

There are quarries at Waterville and Cassville, also in Oneida county, and on the line of the Delaware, Lackawanna and Western railroad. They are in the Corniferous limestone.

**MANLIUS, ONONDAGA COUNTY.**—Loomis' quarry, at Manlius, is in the gray, Onondaga limestone. It is worked for monumental stone and for house trimmings. The locality is on the Syracuse, Ontario and New York railroad line.

The **JAMESVILLE** quarry is in the same range, and it is worked for bridge work mainly. The Syracuse and Binghamton railroad line runs through the place.

**SPLIT-ROCK QUARRIES, ONONDAGA COUNTY.**—These quarries are in the town of Onondaga, five to seven miles westerly from the city of Syracuse. They are opened in the north edge of the Upper Helderberg escarpment. The most eastern opening is that of Hughes Brothers, on the Fay place, five miles from Syracuse, and on the south side of the road, and about two and a half miles east-south-east of the main group of quarries. It was opened in 1877. The earth covering does not average more than one foot in thickness. Thus far only the top course has been quarried, which is 2 feet 6 inches thick. The stone is gray, crystalline, and softer than that of the quarries on the west. It dresses well and makes a good material for house work.

It is worked for lock stone mainly. There are two derricks at the quarry. The stone has to be carted to Syracuse.

The Shonnard Hill quarries are opened and worked by J. J. McLean, Jas. Connor, Cornelius Crowley, and Hughes Brothers.

The Hughes Brothers' quarry, at the south, is the oldest and the largest of this group. The locality has been opened for many years. Two courses or beds only are worked, and together are about 4 feet thick. At the bottom there is a gray limestone, which is seamy. These seams or joints run east and west and dip south, steeply. Blocks of very large size, limited only by the capacity for handling, can be obtained here. The stone is carted to Syracuse, and dressed at the yard of Hughes Brothers.

Crowley's quarry is separated from the above mentioned by a property line only. The beds are horizontal; and the stone is very similar to that of the Hughes Brothers' quarry.

The quarry of James Connor is north-west of that of Crowley's and north-east of that of Hughes Brothers. Along the east-west running face of the ledge, where worked, the top earth is only one foot thick, and the top, quarry bed 2 feet thick, and the second course 2 feet 8 inches. The bottom is a gray, seamy limestone, which is partly used for building purposes. There are two derricks here. The drainage is natural. The blocks are carted to Syracuse, and they go into canal locks and house trimmings.

J. J. McLean's quarry is north-west of the last described, and about 500 feet distant. The earth covering of the strata here is 1 to 2 feet thick, and the strata are horizontal. One main system of joints runs east and west. Only a few feet, at the top, are quarried for lock construction. One derrick is used.

The total area quarried over in these several openings on Shonnard Hill is at least ten acres. About fifty men are employed on an average. There is no water to be raised and no pumping, and the work continues during the whole year. The stone is carted to Syracuse, although the railroad line is within two miles to the north. The formation is known as the "Onondaga gray limestone," and the geological horizon is that of the Upper Helderberg period.

To the east of this group of quarries, as now opened, and a few rods only from the roadside, is the quarry of Cornelius Crowley. The beds at this place dip  $5^{\circ}$  to  $7^{\circ}$  north-east. Two courses or beds only are taken off and they are used for canal locks. The bottom is gray, seamy rock. Still further to the east, and north of the road a



quarter of a mile, M. Degnan has opened a quarry. The gray limestone and associated strata are similar to those at the Shonnard quarries. To the north-east, and across the gulf from the last mentioned locality, is the abandoned quarry of Wm. Liddy.

The Splitrock quarries were worked actively at time of the building of the Erie canal, and many locks on it were of the Splitrock gray limestone.\*

ONONDAGA RESERVATION QUARRIES, ONONDAGA COUNTY.—South of Syracuse and on the Onondaga Indian Reservation, gray limestone is quarried by five parties, all within a range of three-eighths of a mile from north to south. They are in the north-east corner of the Reservation, and are worked at a nominal rental paid to the State. At the north-eastern end of this group of openings is Hughes Bros. quarry. Going south, the next adjoining, is that of John Kelly, Jr., and then the quarries of Patrick McElroy, Wm. Crabtree and D. L. Storrier. The quarries of Hughes Bros., Kelly and McElroy form one continuous opening, which has a length of 250 yards from north to south. The quarry face consists of a wall of rock running in a zig-zag course following the joints or seams. At the north end the beds are horizontal or may dip slightly east-south-east. In McElroy's quarry the dip is to the south-east and at an angle of  $20^{\circ}$ . The seams or joints run nearly due east and west; and another set, less regular, north and south. A vertical section of the strata in Hughes Brothers' quarry has: blue limestone (cherty) ten feet; blue limestone, one foot; gray limestone, six feet, and gray limestone at the bottom. The covering of earth on the rock is rarely more than a foot thick. The joints are plain in the blue stone, but less marked in the gray. The bottom bed, four feet thick, has tight seams or is "bed-bound," and is not worked. A vertical section at McElroy's quarry shows: rock, with earth mixed, 6 feet; blue limestone, 20 feet; gray limestone, 7 feet; and gray limestone at the bottom, 5 feet. The blue limestone is in beds or courses one to two feet thick, and is usually separated by thin layers of shaly rock. It contains much chert. This blue stone cannot be dressed, and only a small part of it is used, for common walls; and for this purpose some of it is carted to Syracuse, but owing to the expense of carting it, the greater part is left on the dump in the quarry. The removal of this *stripping*, of blue limestone, makes the working

\*There was then a population of 5000 people at Splitrock. The old stone tavern, a massively built structure, and 50 years old, is all that is left of the town, and a proof of the durability of the stone.

of this quarry costly. Only the superior value and quality of the gray limestone compensates for the heavy work of *stripping*.

From McElroy's quarry it is 200 yards south-south-west to Crabtree's. This quarry has a face of 200 feet in length. Boulder-drift earth, up to 10 feet thick, covers the blue limestone, and with the limestone, makes a total thickness of 20 feet of *stripping*, before the gray stone is reached. The same gray bed, with tight seams, is seen at the bottom of the quarry.

Storrier's quarry is about 20 rods south of Crabtree's. It was opened three years ago. The beds dip east-south-east, slightly. At the west side the drift earth lies immediately on the gray bed, which is four and a half feet thick. The blue, shaly limestone comes in at the top as you go eastward.

The gray bed seems to run out southward, and beyond Storrier's quarry. The water in these Reservation quarries is raised by siphons and carried over to a stream in the valley on the west side of them. They are worked more or less all of the year, or so long as the weather permits. The stone is all carted by teams to Syracuse, six and a half miles distant. It has a gray color, crystalline texture, and in the market is known as "Onondaga gray limestone." It is a strong and solid building stone, and does not show the black seams, marking some of our limestones, nor *clay seams*, so common in nearly all of the Mohawk valley and Hudson-Champlain valley limestones. When fine cut, the color is light-gray, approaching the best of the Maine granites, and in pleasing contrast to the rock face stone, which is much darker in shade. It has been the principal building stone in Syracuse, and there are many fine structures in that city which are of it. Notable among them are the new U. S. Government building, Hall of Languages, Syracuse University, Onondaga County Savings Bank building, St. Paul's P. E. church, St. Mary's R. C. church, and the May Memorial church. A large amount of this stone has been put into lock facings on the Erie canal, especially east of Syracuse. It has found a ready market in Oswego, Binghamton and other cities in the central part of the State.

UNION SPRINGS, CAYUGA COUNTY.—The Onondaga limestone is opened in a group of quarries at Hamburg, a mile south of Union Springs, and at Mosher's quarry east of the same place.

The quarry of Daniel Mosher is one mile east of the lake. It was first opened many years ago. But little stone was taken out until 1879, since which date it has been actively worked. The quarry is

nearly rectangular in shape and about 300 feet by 100 feet and 26 feet deep. The earth covering on the stone varies from one to six feet thick. The dip of the courses or strata is  $5^{\circ}$  southward. There are two sets of joints or seams ; one south  $17^{\circ}$  east, and a second set east and west. They are at convenient distances apart for working out the blocks of stone, and are generally open. The vertical succession of beds or *tiers* of stone, from the top down is as follows :\*

|                                       |            |
|---------------------------------------|------------|
| 1. Blue limestone .....               | 12 inches. |
| 2. Blue limestone .....               | 16 inches. |
| 3. Blue limestone for flagging .....  | 3 inches.  |
| 4. Blue limestone .....               | 14 inches. |
| 5. Blue limestone .....               | 22 inches. |
| 6. Blue limestone .....               | 4 inches.  |
| 7. Blue limestone .....               | 4 inches.  |
| 8. Blue limestone .....               | 7 inches.  |
| 9. Blue limestone .....               | 8 inches.  |
| 10. Blue limestone .....              | 9 inches.  |
| 11. Blue limestone .....              | 11 inches. |
| 12. Blue limestone .....              | 20 inches. |
| 13. Blue limestone (flag-stone) ..... | 2 inches.  |
| 14. Blue limestone .....              | 8 inches.  |
| 15. Blue limestone .....              | 8 inches.  |
| 16. Blue limestone .....              | 16 inches. |
| 17. <i>Clay</i> .....                 | 6 inches.  |
| 18. <i>Flint</i> .....                | 6 inches.  |
| 19. Limestone .....                   | 16 inches. |
| 20. Flag-stone .....                  | 5 inches.  |
| 21. Limestone .....                   | 27 inches. |
| 22. Limestone .....                   | 12 inches. |
| 23. Limestone .....                   | 7 inches.  |
| 24. Limestone .....                   | 16 inches. |
| 25. Limestone .....                   | 18 inches. |
| 26. Limestone .....                   | 22 inches. |

The bottom is shaly limestone, and under it there is a bed of limestone three feet thick. The strata, or as they are here termed, "*tiers*," are worked up into building stone, canal lock stone, and railroad bridge pier stone, flag-stone and platforms. The bedding faces at this quarry are somewhat rough, and hence the stone is better adapted for heavy work. The stone of the thick beds is gray, sub-crystalline, and

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\* From Mr. Shaper.



dresses well. The product of this quarry is now shipped for canal construction. There is very little water to be raised. Two derricks are used at the quarry and two at the dock on the lake shore. A large amount of stone from this quarry has been used on the Lehigh Valley R. R. at its Vosburg tunnel, Pa.

The *Hamburgh* group of quarries were first opened at least 60 years ago, and the old grist mill in the village was built of this stone ; also the Chase House and the house of Robert Howland. And they are witnesses to its durability.

PHILLIP WINEGAR'S QUARRY is on the east side of the road, and is opened a length of 600 feet. Its working face is 40 to 50 feet deep. A vertical section shows : drift earth, with large limestone boulders, 10 feet thick ; calcareous slate, brown color, two beds, five feet ; blue limestone, in beds, one inch to 24 inches, 30 feet. At the bottom there is a bluish-black, slaty rock. The black, slaty-rock courses at the top answer for common rubble or wall work. The thick beds are used for heavy mason work, for which this stone is specially adapted. The courses, between three and four inches thick, are usually cut into flagging. The succession of beds corresponds with that at the Mosher quarry, and the flinty cap on the 24-inch-bed is 14 feet above the bottom of the quarry. The earthy layer, known locally, as "*soapstone*," also appears in this quarry, and over the "*flint*." Two derricks are in use in the quarry, and one on the dock. A tramway runs from it under the main road to the dock, one-fifth of a mile away. A large force of men is here employed in quarrying stone, and in *stripping* in the winter. At present the output is largely used for the construction of locks on the Erie canal. The stone are shipped by boat on the lake and canal.

THE QUARRY OF A. B. NILES is about 80 yards from the west end of Winegar's, and on the west side of the road. A large area has been worked over. These quarry beds show some disturbance, and as now exposed, the strata dip south, and are also horizontal in places. A track runs from the quarry to the dock on the lake. The place is at present idle.

PATRICK SMITH'S QUARRY is on the hill, 100 yards south of Winegar's, on the east side of the road. At the north end the beds dip 30° north-west, whereas in the centre and in the south part they are horizontal or nearly so. The quarry face is about 600 feet in

length from north to south, and runs in a zigzag course, owing to the rectangular joint walls. It has been worked back about 200 feet from the road, in an easterly direction. At the top there is drift earth and black slate, and the strata are found to increase in thickness as the hill rises, going eastward. The slaty rock can be used for common walls, but owing to a lack of demand, very little of it is sold, and that at 25 cents per perch at the quarry. The succession of strata here seen, is the same as in the other Hamburg quarries, as above described, and there is a remarkable uniformity and persistence in the strata, as opened in the several quarries in the vicinity of Union Springs. The thicker beds of the Smith quarry furnish strong and durable stone for solid masonry. At present the product is largely cut for construction of lock enlargement on the Erie canal, between Rochester and Syracuse. Stone from this quarry was used on the Vosburg tunnel of the Lehigh Valley railroad and in the viaduct of the New York Central railroad at Rochester. The quarry equipment includes six derricks. The stone is carted to the dock, an eighth of a mile away, on the lake, and is shipped by boat over the line of canal.

The quarry industry at Union Springs has not grown, owing to the many new localities which have been opened during the past twenty to thirty years. The canal work has to some extent revived the business. For solid masonry the stone is among the best.

**AUBURN, CAYUGA COUNTY.**—The Upper Helderberg limestone formation, which underlies Auburn and the adjacent country east and west, has yielded a large amount of stone for building in the city; and its percentage of stone buildings is relatively high. The main ledge on the eastern side of the city is continuous from the Osborne works, to and beyond the Goodrich quarry. The old Garrett quarry opened in 1810, is now covered in part, by the Osborne Reaper Works. The present quarry of the Garrett Stone and Coal Company, is east of the old quarry site, in the face of the same ledge. The strata dip gently to the south. The working is intermittent and for local use mainly. Former years saw more work, and the product went into buildings in the city, and to other points also.

**THE QUARRY OF L. S. GOODRICH & SON** is east of York street, and on the same ledge as that of the Garrett quarries. It follows the line of the ledge, and runs in a north-westerly and south-easterly direction for over 1,000 feet, and the face of the quarry fronts the

north-east. At the top, the rock is thin-bedded and shaly. The *stripping* is from six to eight feet thick. At the south end there is three feet of red earth on top of the limestone. The beds dip gently southward. The joints are regular, nearly vertical, and at right angles to one another. The main system runs a few degrees north of east. A vertical section of the beds here worked is as follows :\*

|  |             |
|--|-------------|
| 1. Blue limestone (for rubble work).....     | 14 inches.  |
| 2. Shaly limestone (worthless).....          | 14 inches.  |
| 3. Gray limestone (curb tier).....           | 18 inches.  |
| 4. <i>Flint</i> .....                        | 1-3 inches. |
| 5. Gray limestone, for cut work.....         | 14 inches.  |
| 6. Gray limestone.....                       | 6 inches.   |
| 7. Gray limestone (for large platforms)..... | 12 inches.  |
| 8. Gray limestone (heavy tier).....          | 23 inches.  |
| 9. Gray limestone (extra good).....          | 12 inches.  |
| 10. Gray limestone.....                      | 24 inches.  |
| 11. Light-blue limestone.....                | 5 feet.     |
| 12. Blue limestone.....                      | 3 feet.     |
| 13. Blue limestone.....                      | 4 feet.     |
| 14. Blue limestone.....                      | 1½ feet.    |
| 15. Blue limestone.....                      | 5 feet.     |

Water-lime rock at bottom.

The gray limestone of *tiers* Nos. 3, 5, 6, 7, 8 and 9, of the above section, is used mainly for dimension work, for curbing, gutter-stone, platforms and house trimmings. It is gray and of uniform shade and sub-crystalline in texture. The bottom bed of gray limestone is especially adapted for sills, lintels, water tables and house work generally. All the gray stone dresses *true* and when fine cut, has a light-gray color, making a pleasant contrast with the plain, rock face. The cartage is by teams to railroad, one mile away. The quarry plant includes four derricks and one steam drill. It is above the natural drainage, and no pumping is necessary. The output for 1887 was valued at \$35,000, and about 60 men were employed. This quarry was opened in 1863.

JOHNSON & PARSELL work a quarry in the same ledge, but lower and at the valley level. It has a face 30 feet high. The stone is blue, hard and brittle, breaking with a conchoidal fracture; and the *tiers* are six inches to two feet thick. A small quantity is taken out annually for common wall work.

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\* Figures are from Mr. Goodrich.



BENNETT's limestone quarry is west of the city. Only one to two men are employed and the product is unimportant.

The gray limestone of these Auburn quarries has been used largely and effectively in the five beautiful church buildings; in the city hall; in twenty-two store-houses; in the buildings of the Auburn Theological Seminary; the State Arsenal and the State prison. They witness to its beauty, both when fine dressed and as rock-face ashlar.

SENECA FALLS, SENECA COUNTY.—Small quarries, worked at intervals and for local use only, are opened in the limestone along the river at Seneca Falls.

WATERLOO, SENECA COUNTY.—Two quarries are opened and worked near Waterloo. They are in the Corniferous limestone formation.\*

John Emmett's quarry is on the Seneca canal, one mile west of the town. A large space has been uncovered and quarried over. The covering on the stone is from four to ten feet thick; and the quarry courses or beds of blue limestone are, from the top down, as follows: 24 inches, 12 inches, 10 inches, 18 inches, 7 inches, 8 inches, 8 inches, 26 inches, 16 inches, 12 inches, 15 inches, 18 inches, 9 inches, 18 inches or 14 courses, which are quarried, and which have an aggregate thickness of 17 feet, nearly. The drainage of the quarry is into the Seneca river. The stone has been used in canal-lock construction and in churches in Geneva and Waterloo. The quarry was first opened in 1842.

Loren Thomas's quarry is half a mile south of the town, and the same distance from the N. Y. C. R. R. and the Erie canal. A large area has here been worked over, having a length of 1,000 feet or more from north to south. It has been worked for 60 years, having been opened first by the father of the present owner. The top earth is here from three to ten feet thick. The beds have a dip of  $2^{\circ}$  in a southerly direction. They are divided by joints, or seams, which run vertically, nearly west of north, at intervals of 30 feet or so apart, and the second a few degrees south of east at about the same distance apart. These joints assist very materially in the working of the quarry. A vertical section shows the following strata:

- |                         |            |
|-------------------------|------------|
| 1. Blue limestone ..... | 25 inches. |
| 2. Blue limestone ..... | 12 inches. |

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\* The formation is locally known as the Seneca blue limestone, and is in the upper part of the Corniferous or Upper Helderberg group.

|                              |                           |
|------------------------------|---------------------------|
| 3. Blue limestone .....      | 16 inches.                |
| 4. Blue limestone .....      | 20 inches.                |
| 5. Blue limestone .....      | 7 inches.                 |
| 6. Blue limestone .....      | 9 inches.                 |
| 7. Blue limestone .....      | 7 inches.                 |
| 8. Blue limestons .....      | 22 inches.                |
| 9. Clayey earth .....        | 7 inches.                 |
| 10. Chert on limestone ..... | { 6 inches.<br>17 inches. |
| 11. Limestone .....          |                           |
| 12. Limestone .....          | 14 inches.                |
| 13. Limestone .....          | 11 inches.                |
| 14. Limestone .....          | 16 inches.                |
| 15. Limestone .....          | 17 inches.                |
| 16. Limestone .....          | 18 inches.                |
| 17. Limestone .....          | 9 inches.                 |

The total thickness of the section is 18 feet 7 inches. At the south side of the quarry, at the top, there is more shaly stone, which answers for common, wall work only.

There are several derricks in use, worked by horse power. One steam pump raises the quarry water. The stone is carted to the railroad and the canal. The product is largely used for house work, canal and railroad bridge construction. The Waterloo stone can be seen in the basement of the Protestant Episcopal and in the Roman Catholic churches in Waterloo.

The Corniferous limestone formation has been opened in small quarries at Phelps Junction, in Gidding's quarry Canandaigua, and at Hog Hollow in the town of Victor, all in Ontario county. They do a local business.

**LEROY, GENESEE COUNTY.**—Two quarries are reported as opened at Leroy for building stone. They are in the Upper Helderberg or Corniferous limestone formation. The stone does for common, wall work, and fills the local demand, but it is not exported to any extent. Some of the limestone which crops out north of the town, is said to dress and polish well.

The same limestone formation has been opened in a small quarry at Caledonia, in Monroe county.

**WILLIAMSVILLE, ERIE COUNTY.**—Several quarries have been opened at Williamsville, ten miles north-east of Buffalo. J. S. & F. H. Youngs, and D. & H. Fogelsonger work quarries for building

stone, mainly for the Buffalo market. They are small and are not deep, as the rock is near the surface. The stone is light-gray, fine-crystalline and dresses well. It is used in Buffalo for cut stone trimmings. The quarries are six miles from the N. Y. C. R. R. line, but nearly all the stone is carted by teams to Buffalo. The geological formation is Corniferous.

**BUFFALO.**—In the city of Buffalo, a great part of the stone used in retaining walls, common walls, foundations and basements, as well as inside walls, has been obtained from quarries within the city limits. A group of these quarries is in the north-east part of the city, on the east side of Avenue A. The most northerly opening is that of the Buffalo Cement Company. At this quarry the Corniferous limestone is six feet thick, and rests upon an even-bedded, gray limestone, which may be eight feet thick, and underneath which, the cement rock is found. The limestone from this quarry is sold for building purposes in the city. The average price is \$6.00 per cord. The main group of quarries is south of East Forest avenue, The first one at the north, and near the street, is that of Emilie Sutter ; the next, south, is that of Joseph Armbruster, and adjoining it is that of John Gesl. These quarries really make one opening, the dividing line being simply that of property. Armbruster's quarry is nearly worked out, as this property has nearly all been quarried over. At the south side the face shows 18 to 20 feet of strata, extending from Avenue A to Gesl's line. A very plain system of joints runs east and west, vertically. There are two derricks, and the quarry is worked in a small way.

**GESL'S QUARRY** covers an area of two or three acres. The quarry beds are overlain by drift earth, varying from a few inches to four feet thick. They are even-bedded, horizontal, and from nine inches to two and a half feet thick ; and the total thickness averages 20 feet. The stone is dark-colored, dense, hard, and contains much chert, particularly near the bottom. The top beds are generally thin, and the stone from them is used for common walls, selling at \$6.00 per cord, delivered in the city. The heavy beds are cut into stone for locks, bridges, etc. There is very little water, and the drainage is natural. Two derricks are in use. A main system of joints run vertically east and west at spaces about 20 feet apart, on an average. The other seams or joints are vertical, but run in an irregular course.



**JOHN ORTNER'S QUARRY** is a quarter of a mile east of Gesl's. The quarry beds at this place, have a total thickness of 18 to 20 feet. One derrick is used, and a small force of men is employed.

The **QUARRY OF CUTTER & BAILEY** is south of that described above, and covers an area of at least 10 acres, having a working face of 1,000 feet in length from north-east to south-west. The strata are horizontal, with vertical joints or seams, 20 feet apart, and running east and west. There are ten beds, of which the thickest is two feet, and together, 18 to 20 feet thick. The *stripping* ranges from a thin soil to earth, three feet thick. The beds are above natural drainage. The plant consists of four, horse-power derricks. About 50 men are employed a large part of the year. The stone from these quarries is all sold in the city, and is carted by team from them to the spot where it is to be used.

**ROCHESTER.**—The Niagara limestone formation furnishes a large part of the common building stone used in this city. The quarries are located in the north-eastern and in the western parts of the city; and, generally, the stone is covered by a few feet of earth and boulder drift. One of the largest openings in the city is that of Foery & Kastner, on the east side of North Goodman street and in the north-eastern part of the city. At this place about two acres have been gone over to a depth of 25 to 30 feet. On the top there is an uneven bed of gray limestone. It is underlain by 15 to 18 feet of even-bedded stone, of a darker shade in color, resembling some of the Trenton limestone. The gray limestone dresses more readily than the latter, and is the best of the quarry. This stone is used for cellar walls, foundations, basement and party walls, and to a slight extent, as rock faced ashlar, for building purposes. Steam pumps for raising the water and steam drills are used. The average price is \$1.00 per load at the quarry, and it is sold in the rough to builders, who put it in rubble work or square it for course work.

**LOCKPORT, NIAGARA COUNTY.**—The Lockport gray limestone is quarried in the city by Chas. Whitmore and by B. & J. Carpenter. The quarries are in the south-west part of the town, along the canal, above the locks and south of the N. Y., L. E. & W. R. R. Whitmore's quarry is worked in a small way, at intervals. The Carpenter quarry has an opening on both sides of the canal, but the main working is now on the north side. The beds are above the canal level, and the quarrying work has extended over a distance of 200 yards from

north-east to south-west, and back nearly to the railroad line, making an area of several acres from which stone is extracted. The locality was first opened when the canal was dug, in 1825; and the Carpenters began work here in 1829. The stone is covered by soil, and the top beds are thin, for three feet or so in depth; then comes the gray limestone, having a thickness of 12 to 24 feet. At the bottom there is hydraulic limestone, six feet thick, and under it a black, shaly rock. The quarry stone has a grayish shade of color and crystalline texture. The beds dip south at a low angle. There are no seams or regular sets of joints in the rock. It dresses well; is solid, dense and specially adapted for heavy masonry, as well as for house trimmings and cut work. When fine cut the surface is not very different in shade from the rock. Formerly a large amount of stone was quarried here for building purposes, but since the great increase in the use of sandstone this limestone has been comparatively neglected. It has been used for monumental work also. At the present time the stone is being quarried for canal lock construction. There are three derricks in the quarry, besides a double, traveling shed derrick.

The Lockport gray limestone has been employed to a large extent in stone construction at home, and the curbing, crosswalks, canal locks, N. Y. C. R. R. viaduct, several store-houses and church buildings, shows how well it stands the exposure of years, and its durability. As a cut stone for trimming, with brick walls, it has been used extensively. Outside of Lockport it has found markets in Buffalo, Niagara Falls and other cities. A fine example of the stone, fine dressed, is in the Lenox Library building, on Fifth avenue and Seventieth street, New York city.

NIAGARA FALLS.—The Niagara limestone formation, affords stone for building in the Falls village, and small quarries are opened in the vicinity of the place. They do not sell stone to other points.

# SLATE.

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SHUSHAN, WASHINGTON COUNTY.—A slate quarry was opened here about four years ago, on lands of Daniel Dobbins, near the Batten Kill, and one mile south-west of Shushan. There are two openings about 50 yards apart, in a northerly and southerly line, and about 150 yards south-west of Dobbins house. This quarry was reopened in 1887 by a New York city firm, and was worked about six weeks. The main opening is 75 yards long, and about 30 yards wide and 40 feet deep. The bed dips at an angle of  $40^{\circ}$  eastward. There is very little earth on the rock, and originally, the slate cropped out. The rock on the west and south sides of the opening is purple, green and variegated in color. Two derricks, worked by horse power and a shanty, with a trimming machine, make up the quarry plant. The work had been suspended at the time of visit, and the bottom of the quarry could not be seen. A small stock of roofing slate was on the bank.

SALEM, WASHINGTON COUNTY.—South-east of Salem a half a mile, three quarries have been opened for roofing slate. Two of these quarries are worked by C. H. Pierce, and the third by John N. Williams & Co. The Pierce quarries were opened three years ago, and the excavations are about 40 feet deep. The southern opening is about 40 x 60 feet in size. The drift earth which covers the slate averages seven feet in thickness. The beds dip at an angle of  $20^{\circ}$  east-south-east. The north-east opening is small and is now idle. These quarries produce roofing slate and flag-stone. The stone, unsuited for roofing or for flagging, is used in the town for walls and foundations.

The Hawley Farm quarry, about 300 yards south-west of the Pierce quarry, is leased and worked by John N. Williams & Co., and was opened the last season (1887). It has reached a depth of 45 feet on the dip, but is only about 30 feet square. The strata dip  $40^{\circ}$  east; the cleavage is in the same direction. The slate has a greenish color, and is known as fading green. The water is raised by a barrel, and a one-horse derrick answers for hoisting the slate. This quarry has not been opened sufficiently to develop a large body of good slate, but it is promising.



KAYS' QUARRY also is in the town of Salem, and on the Christopher Morey farm, in the Black creek valley, and four miles north-west of Salem. It was opened in April, 1886, by Hugh Kays, of Salem. The opening is 60 x 40 feet, and 45 feet deep. The slate is red and is said to be quite as deep-colored as that of Granville.

In what may be the same range (or "vein" of the slate quarrymen), there is the Douglass quarry, which is located about three and a half miles south-south-west of Granville and near Slateville, in the town of Hebron. It produces a red slate. During the past season it was idle.

GRANVILLE.—The Granville red-slate *vein* or range is traceable for two miles northward from Granville, east of Middle Granville, and nearly parallel to the Vermont line. It is narrow, in places not over 30 rods wide, and its surface very rocky. The strata crop out in numerous low, glaciated knobs and ledges. Quarries and trial pits have been opened at many points. The following quarries are noted here, beginning at Granville :

The quarry of Evan J. Roberts and John Hughes is in the northern part of the village of Granville, and about 100 feet west of the Middle Granville road and the D. & H. R. R. line. The opening is 150 x 45 feet, and 20 to 30 feet deep. The beds dip  $50^{\circ}$  south  $82^{\circ}$  east. One system of joints runs north  $85^{\circ}$  west and is vertical ; a second, has its joint faces dipping  $40^{\circ}$  west. The covering of earth on the slate rock at this opening, was not more than two feet thick at any point, and the rock, as seen in the outcropping ledges near the quarry is solid and hard. Some white calcite and milk-white quartz are seen in the joint surfaces. The cleavage coincides with the dip of the beds. The varieties of slate here obtained are green and red. The red slate is fine-grained, homogeneous and bright-red in color. There is one derrick on the dump, at the south end. The quarry has not been in operation during the past season.

Going north on the line of the red-slate "vein" the next opening is about 120 rods to the north, and 40 rods east of the railway. It is small and at present, partly filled with water.

The quarry of John J. Williams is north of the last mentioned locality, and on a ridge about 50 feet above the Granville terrace, and perhaps 80 rods from the railroad. The opening is 100 feet long and nearly as wide. The depth averages 50 feet. The beds dip  $40^{\circ}$  east-south-east. One well-marked joint system runs east and west. The second is less plainly marked, at right angles to the first ; and

both are vertical. The cleavage planes have the same direction as the bedding. The greater part of the slate obtained in this quarry is red. The quarry is unwatered by means of a siphon ; and the slate blocks are raised by one derrick, worked by horse power.

North of the Williams quarry and on the same ridge two quarries have been opened and worked, but work in them has been discontinued.

The quarry of Wallace & Hitchcock, north of these abandoned quarries, is also idle. At all of these openings the slate rock shows the same general direction in dip, and at an average angle of  $38^{\circ}$  to  $40^{\circ}$ .

The quarry of Hugh Williams, on the Hammond farm, is about a quarter of a mile north of the last mentioned locality. It is about 80 by 40 feet. The dip of the strata is eastward or east-south-east. This locality also has been idle for three years.

Going north, the quarry of William F. Williams & Sons, is on lands of W. Crosby. The opening is in a low depression or wet swale, at the eastern foot of a low lying ledge of red-slate rock. The slate here was found covered by a thin bed of white, clayey earth. The quarry dimensions are 100 feet by 50 feet, approximately ; and 55 feet deep. The dip of the strata and of the cleavage plane is  $45^{\circ}$  easterly. One main seam or joint system is vertical, and runs east and west. Both green and red slate are found in these quarries. The green variety is seen crossing the strata obliquely. A steam pump, running for five hours a week, raises the quarry water. The slate blocks are raised by a horse-power derrick. This quarry was opened four years ago.

The quarry of Wm. A. Nixon also is on lands of W. Crosby, and a few rods only, north of the Williams quarry. There are two openings, and they are close to the road, on the south side of it. At the southern one, which was begun in the season of 1887 a depth of 25 feet has been reached. The strata dip south  $75^{\circ}$  east, and at an angle of  $45^{\circ}$ . A red slate is obtained here, but the place is not yet opened fairly to indicate its value. The old quarry of Nixon, which is now idle, is several rods north of the above and near the road. A large amount of roofing slate has been taken from it and the heaps of waste rock about it are large. Nixon's quarry is east of, and in beds a little higher than those of Williams', and, apparently, higher than those which are opened on the north and across the road. It is a half a mile south-east of Middle Granville.

A few rods north of the main road, and on the Crosby property a slate quarry has been opened and worked by a Boston company. It is located on the eastern side of a low and rocky ledge, and the covering of white, drift clay on the slate was much like what was seen at Nixon's and at Williams' quarries. This opening is about 50 feet square, and 25 to 30 feet in depth. Both green and red slate occur in this quarry. The beds and cleavage planes dip at an angle of  $40^{\circ}$  easterly.

About 50 yards north of the Boston company's quarry there is an old opening, which is now partly full of water; and north of the latter are the abandoned workings of the Eagle quarry. All of these quarries produced a red slate. In the same range, and a few rods north of the old Eagle quarry, slate is raised by Robert B. Pritchard. He has two openings, of which the southern one only, is worked. It is about 50 feet square, and 30 feet deep. The covering and the location are very similar to the neighboring quarries to the south. The beds dip about  $40^{\circ}$  a little south of east. The main system of joints runs in the line of dip, and they are vertical. The slate has a deep red color. One derrick, worked by horse power, serves to raise both the stone and the water, of which there is at times a great deal, as the location is swampy. These quarries are within a half a mile of the railroad station at Middle Granville, where the slate are loaded and shipped to market.

**MIDDLE GRANVILLE.**—In the village of Middle Granville a slate quarry is opened and worked south of the main road, and on the west side of the Pawlet river. It is located on flat ground but a little above the stream, and the covering of drift earth is only a few feet thick. This opening approximates about 250 by 80 feet in size, and has a depth of 50 feet. The bed dips  $30^{\circ}$  east-north-east. The main joint system runs in the same direction and dips very steeply southward. At the north end of the quarry there is a slip, or joint, whose planes dip at an angle of about  $60^{\circ}$  east. The purple, green, and variegated varieties are here obtained; and the greater part of the output is split into roofing slate. One derrick, worked by horse power answers for raising the water and slate.

**PENRHYN STATE COMPANY'S QUARRIES.**—These quarries are from a quarter to three-quarters of a mile north of Middle Granville, in the eastern side of a steep ridge of slate rock. The slate has been opened at several points on the lands of the company, and on the adjoining



farm of John Fyfe. The three southern openings or quarries, are quite close together, and west of the mill. The first one is approximately 300 x 200 feet, and nearly 100 feet deep, and the second, 200 x 100 feet, both being 10 to 20 feet deeper at the upper or west side. At present they are partly full of water, and the only work is in the top rock at the side of the southern-most pit. The main quarrying of the company is now on the Fyfe property, and in what are here known as Nos. 1, 2 and 3. They also are large pits, and from 70 to 100 feet deep. The dip of the strata in all of these quarries is east, and at an angle, on average, of  $40^{\circ}$  to  $50^{\circ}$ . Green, purple and variegated slates are obtained, and, generally, these different colored rocks occur in separate beds. The variegated consists of green and purple mixed. The joints or seams traversing the rock, are not well defined in these quarries. Generally, one system runs in the same direction as the dip of the beds, that is easterly, and vertical. A very large amount of material has been taken from the openings in this hill, and the high dumps indicate the extent of the work, as well as show how much waste is incidental, necessarily in opening and developing slate quarries. There is not much machinery employed, other than horse-power derricks and pumps run by steam power from the mill. At all of these quarries in the side hill adits and short tunnels admit of unwatering, down nearly half the depth, and save some hoisting. The splitting and trimming of the roofing slate are done in shanties or booths, on the dumps at the quarry. The blocks for cutting are hauled by teams to the company's mill, which is within a half a mile of the furthest quarry. The work of getting out slate at the quarries is done on the contract system, the men furnishing the blocks of slate at certain rates, according to the stock which is cut from them. The company works up the product of the quarries in its mills, except a comparatively small part which is split up into roofing slate. The greater part is worked up into plain, marbleized, decorative and enamelled material, as mantles, steps, house trimmings, table tops, laundry tubs, wainscoting, floor tiles, etc. The purple and green slates are generally used for marbleizing, as they are more abundant, softer and cheaper than the red, which finds a market for ornamental work. The purple slate of these quarries is deeper and richer in color than the Vermont purple slate. The latter has more of a brown shade. The Middle Granville quarries were first opened about 1850.

The Penrhyn Company's mill is east of the quarries and at the side of the Pawlet river. It is equipped with machinery for cutting,

rubbing and marbleizing slate, and it works up a large amount of slate rock from other quarries, both in this county and in Vermont. It is the only establishment of the kind in the State. Their other mill is at Hydeville, Vermont. The product of the mills is 14,000 square feet per month.

The **METTOWEE RED SLATE COMPANY** operates a quarry of unfading green slate on lands of the Empire Slate Company, three miles north of Middle Granville, and on the west of the Rutland & Washington railroad. It is in the town of Granville. The quarry is considered as one of the best of the green-slate range in this section. The slate is a gray-green in color.

Red slate has been worked on the east side of the Pawlet river, north of Middle Granville. The quarries are as yet small and not productive. They are west of the Granville range.

On the **TERENCE CROTTY** farm, one and three-quarters of a mile north of Middle Granville and east of the E. Whitehall road, there are three openings in red slate. They have not been worked in four years.

The **ALLEN SLATE QUARRY** is about 50 rods north of Crotty's, on the west side of the road and near the Allen farm-house. It was first opened in April, 1883, and worked up to two years ago by the Mettowee Red Slate Co., Hugh Williams, manager. The excavation is approximately 150 x 30 feet, and 60 feet deep. The average dip is 70° east. The earth on the rock is thin, and the top rock, where it has been uncovered, appears to be solid and unaltered. The slate is bright red in color. When worked the percentage of waste was said to be unusually small.

The Mettowee Red Slate Company furnished red slate for the Union League building and the Vanderbilt house in New York city, and for the Mark Hopkins house, at Great Barrington, Mass.

**METTOWEE OR NORTH BEND RED SLATE.**—North of the Pawlet river, and about one and a half miles north of the steel bridge two quarries have been opened lately. They are in the town of Granville. What is known as the Pinkham quarry is about 100 yards west of the East Whitehall road. The quarry has reached a depth of about 50 feet, and its estimated length is 80 feet. The beds dip 42° eastward. The covering of earth is from 1 to 3 feet thick, but about

15 feet of the top rock is not workable, and is included in the *stripping*. There is a little green slate on the east side, at the top but the mass of the quarry is bright-red in color. The main system of joints run east and west and vertical. A second system runs obliquely to the first, south-south-west, and dips steeply to the west-north-west. The company working these quarries is known as the Anniflan Slate Trust, of Boston, of which Geo. F. Pinkham is the principal owner. It was first opened about three years ago. The present company reopened it in July, 1887. The plant consists of one derrick and one pump, both run by steam power.

Half a mile north of the above is the quarry of Hugh Williams, of Middle Granville, and on lands of Edward S. DeKalb. The opening is about 80 feet by 50 feet, and at least 30 feet deep. The *stripping* is drift earth, and about three feet thick. The lower beds dip uniformly at an angle of  $40^{\circ}$  north  $85^{\circ}$  east, and the cleavage planes have the same direction. The main system of vertical joints runs north  $80^{\circ}$  east; the other sets of joints are quite irregular. The beds have been worked down 60 feet on the foot-wall of the quarry. The color is bright red. The best material is split into roofing slate. The more solid stone of the waste or refuse is used for building stone. One derrick serves for hoisting the stone and water. The quarry was first opened in 1884; it was reopened April, 1887.

The slate from these quarries is carted to the railroad at Middle Granville, three and a half miles distant. At Raceville the railroad is within one and a half miles of the quarry.

**EAST WHITEHALL, WASHINGTON COUNTY.**—This range, or *vein*, of red slate, is in the town of Whitehall, nearly six miles from Middle Granville, and the same distance south-east of Whitehall. The locality is known as Hatch Hill. There are four quarries, opened within a length of a half a mile, from north to south, on the line of strike of the rock. The surface is wet and swampy, and on the west there is a ridge about 100 feet high above the quarries.

W. A. Nixon has the most southern opening on the hill. It is not yet developed into a producing quarry, although good, workable slate rock has been uncovered.

R. A. Hall's quarry is at the edge of the swamp on the south and close to the hill, on the west side. It is about 200 by 100 feet and 100 feet deep on the western foot-wall. On the east side the slate is covered by swamp earth and clayey drift; on the west the rock crops out in the surface. The beds dip easterly at an angle of  $40^{\circ}$ .



Red slate is quarried here, and the greater part of it is worked up into roofing material and tiles for flooring. The mill for sawing the tile is at the east side of the quarry. Steam pumps, steam drills and steam derricks are here in use. From eighteen to twenty men are employed during the working season. The manufactured slate and tile are carted to Whitehall, six miles north-west of the works, and there shipped to markets.

The Hall mill for tiles is located at North Granville. A novel use of the waste from this quarry is grinding it for paint. It is used as a filler in making oil-cloth also. The Hall quarry is represented in the Gilsey House, New York city.

The Ainsworth quarry is about 40 rods north of that of Hall, and is in the low ground. Its dimensions are, approximately 150 feet on the line of strike by 80 feet in width, and 80 feet deep, at the east side. The beds here opened are a little west of the range of the Hall quarry, and lower. There is a remarkable fold in the strata, thus exposed in the vertical sections of the north and south walls of the quarry; and the arch or crown is seen at the west and the axis further east, dipping eastward at about the same angle as the dip of the strata above and below it —  $40^{\circ}$  south  $82^{\circ}$  east. The rock in this fold and middle section of the quarry is hard and does not work well, and it is thrown out as waste. The best material is found in the bottom beds, under the fold. The main system of seams, or joints, runs an east-west course, vertically; a second set, with calcite-coated surfaces, trends in an east-north-east direction, and vertically. The quarry water comes largely from the swampy surface. It is raised by a steam pump. The hoisting of the slate blocks is by a horse-power derrick. The slate is of bright-red color, and homogeneous in texture. A part is worked into roofing at the quarry, and a part is carted to Middle Granville, and thence is shipped to the mill at Castleton, Vermont, where it is cut into tiles, sills, lintels, billiard table tops, etc. This quarry is on the Holcombe farm. Hiram Ainsworth, of Castleton, Vt., is the lessee. It was opened first fourteen years ago. The working season lasts from nine to ten months each year.

Herbert's quarry consists of two small openings about 200 yards north of the Ainsworth quarry. The southern one only is worked. The dip of the strata here is  $45^{\circ}$  (approximate) and eastward. The slate is bright-red, and it is well exposed in the outcropping ledges near the quarry on the west side. The surface rock has somewhat of red

shale interstratified with the slate. The work of pumping and hoisting is done by steam power. Roofing and tile slate are produced. The red-slate outcrop is traceable north from the quarry, up the hill to the road and thence onward.

The East Whitehall slate is noted for its bright, cherry-red color, its fine, homogeneous texture, and its freedom from pyrite. As compared with that of the Granville range or *vein*, it is brighter in color, it is worked more easily, and it is considered by slate men to be superior for roofing material.\* The *vein* is more persistent and uniform in character than the latter. The output of these Hatch Hill quarries varies from year to year. In 1887, they produced about 1,500 squares of roofing slate besides the sawed stock. It sells for \$10 per square, delivered on cars or boat; and there is a steady demand for it.

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\* It should be stated here that the East Whitehall quarries are nearly twice as deep as the quarries in the Granville red slate range or *vein*, and generally in all districts the quality improves as the quarries get deeper in the rock.





# APPENDIX.

## STATISTICS OF QUARRIES.

According to the statistical tables of quarries and their production, in Volume X, pp. 46-49, tenth census of the United States, 1880, New York had 55 marble and limestone; 181 sandstone; 3 crystalline siliceous rock; and 12 slate quarries, which did a business, each of over \$1,000, during the year that the census was taken. There were 3,302 laborers employed in these quarries and the value of the product was \$1,261,495.

The survey for this report shows that in 1887 the number of working quarries was 342; and distributed as follows:

|                            |                |
|----------------------------|----------------|
| 1. Granite and gneiss..... | 11 quarries.   |
| 2. Marble.....             | 7 quarries.    |
| 3. Sandstone.....          | 235* quarries. |
| 4. Limestone.....          | 73 quarries.   |
| 5. Slate.....              | 16 quarries.   |

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342

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The total number of laborers employed, including quarrymen and stone-cutters at quarries, was 5,400,† an increase of one-third over the number reported by the United States census.

The value of the equipment or plant is estimated to be not less than \$1,600,000. It represents the machinery, tools and sheds necessary for quarry work, and excludes mills for cutting and dressing the stone.

|   |              |
|---|--------------|
| The value of the product (estimated at).....  | \$3,500,000‡ |
| The value in 1880 (United States census)..... | \$1,261,495  |

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\*Including 144 quarries in the Hudson River blue-stone belt of territory, as reported in the United States census for 1880.

†The number of men employed in the quarries and in the quarry districts is from individual statements of owners or managers in great part; a few localities are estimated; and the Hudson River blue-stone district estimate, of 2,000 men, is from Wm. B. Fitch, of Kingston, Ulster county.

‡The total value is made up of statements for the several, larger quarry districts, obtained from managers well acquainted with the extent of this industry, supplemented by estimates made in the office, and based on the comparative number of men employed.

## HUDSON RIVER BLUE-STONE.

The following statistics of blue-stone for the year 1887 are furnished by the Union Blue-stone Co., 280 Broadway, New York.\* They show the amounts of the different grades which were quarried and the several uses to which they were put.

OUTPUT OF BLUE-STONE BY UNION BLUE STONE COMPANY, 280 BROADWAY, NEW YORK, FOR YEAR 1887.

| DESCRIPTION.                             | Feet.     | Pieces. |
|--|-----------|---------|
| Flagging. ....                           | 3,188,217 |         |
| Platforms. ....                          | 29,019    |         |
| Rock. ....                               | 23,878    |         |
| Cut garden. ....                         | 25,793    |         |
| Curb. ....                               | 877,424   |         |
| Gutter. ....                             | 126,539   |         |
| Sills. ....                              | 426,671   |         |
| Coping. ....                             | 343,020   |         |
| Door sills. ....                         | 3,639     |         |
| Steps. ....                              | 12,234    |         |
| Belgian bridge crossings. ....           | 150,920   |         |
| Rubbed sills. ....                       | 125,791   |         |
| Rubbed curb and lintels. ....            | 67,276    |         |
| Axed, twenty-inch curb. ....             | 40,129    |         |
| Rubbed flagging and hearths. ....        | 55,815    |         |
| Planed flagging. ....                    | 160,311   |         |
| Planed headers. ....                     | 57,252    |         |
| Planed platforms. ....                   | 31,897    |         |
| Sawed and planed. ....                   | 58,734    |         |
| Well stone. ....                         | 8,496     |         |
| Elevated railroad foundation stone. .... | .....     | 3,467   |
| Corners. ....                            | .....     | 1,340   |
|  | 5,753,055 | 4,807   |

In addition to above there was \$93,000 of manufactured stone sold for building and other purposes.

As these figures represent nine-tenths of all the blue-stone, which is quarried in the State, the total output may be safely stated to be 6,400,000 feet, and its value, in round numbers, \$1,750,000.

## SLATE.

The output of red-slate, in roofing, for 1887, is reported by W. A. Nixon of Middle Granville, to amount to 5,000 squares.

\* Union Blue-Stone Company, Sam'l Coykendall Pres't, and Sam'l Coles, Treasurer.

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